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the COVID-19 case

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Scientific Editors' Note

It could appear that at the beginning of 2020, IT and its various applications, to a sufficient but not burdensome degree, are slowly taking over all spheres of human activity, both those related to work and those broadly understood as entertainment, dominating the dissemination of information and interpersonal contacts. No crisis could jeopardize this slow yet positive, though somewhat sluggish, tendency. No one however predicted the coronavirus (COVID-19) pandemic or the global crisis that it caused.

The time of the pandemic created seemingly ideal conditions for the accelerated advancement of electronic, remote commerce, entertainment, remote learning and the development of their supporting fields such as delivery. Significant limitation of direct interpersonal contacts, confinement to home, isolation of people suspected of suffering from the disease, local and international mobility restrictions, prohibition of access to forests, cultural sites, etc., which were utterly absurd and resulted from the powerlessness of the authorities in the face of the pandemic and their hypocrisy towards members of their own communities (admire us – we are fighting for your health), perfectly fit into the climate conducive to the development of everything that is “networked”.

Yet in the back of our minds, the following question lingers on: is this favorable climate properly and efficiently taken advantage of and can it really – not even somehow replace – but at least become an earnest of normality? Is the social familiarization with the use of remote communication and contact platforms in any way capable of replacing the social mechanisms formed over the centuries? Is it only needed for the political, corporate and administrative authorities at all levels to subjugate societies and to test their patience in prolonging this process? What is the role and place of information technologies in these processes? Do these technologies really deepen globalization as perceived by the public opinion or, on the contrary, reveal the gravest human vices?

These are serious questions on the brink of existentialism (where did we come from, where are we, where are we heading?). Is freedom in networks a manifestation of broadly understood humanity or just a reflection of the human attitude to modern technology? Is it really possible, in this case, to speak of freedom at all, and thus also of humanity? How about the economic, organizational and cultural implications?

These are weighty questions and I am afraid that this “Management Issues” cannot tackle them. Many years' in-depth research can and needs to

be carried out on the role of information technologies in the development of societies – especially in times of economic, political, biological, climate and other crises.

Hence, it is time to start the discussion on this topic and it seems that the articles in this Issue meet at least this condition, namely they are immediate accounts of the research on the role of IT during the COVID-19 pandemic. Their certain “roughness” results precisely from their current, quick view of the reality. They are also a kind of overview of areas and problems where the impact of COVID-19 is most visible.

This Issue consists of the Introduction and eleven substantive articles that, to a greater or lesser extent, address the problems related to the current COVID-19 pandemic.

The work by Jolanta Wartini-Twardowska, Dariusz Grabara and Ewa Ziemba, entitled *“The Influence of the COVID-19 Pandemic on the Use of Digital Technologies by Scientists: A Comparison Between Poland and Abroad”*, introduces the issue of information technologies during the COVID-19 pandemic. The purpose is to identify persistent differences in the frequency of using digital technologies by scientists to support research in the periods before, during and after the coronavirus pandemic. This broadest time perspective also permits looking at a wide spectrum of areas affected by the current crisis with hindsight. A similar perspective is presented in Dariusz Grabara’s article *“Influence of the COVID-19 Pandemic on the Vignette Factors of Smartphone Auctions on the Allegro Auction Platform”* focusing on changes in the usage of auction vignette factors on the Allegro sales platform. That research, like previous research, was performed at three points in time, considered as the pre-pandemic, deep-pandemic, and post-pandemic state. The article by Witold Chmielarz, Marek Zborowski and Alicja Fandrejewska, entitled *“The Impact of the Pandemic (COVID-19) on Globalization – The Perspective of Electronic Commerce”*, examines the influence of e-commerce on globalization and the impact the pandemic on the acceleration of globalization. An article addressing financial services before and during the pandemic is by Gertruda Uścińska and is entitled *“ICT Solutions in the Activities of the Social Insurance Institution (ZUS) as an E-Administration. Evolution During the COVID-19 Epidemic (Case Study)”*. It presents the evolution of selected ICT-based solutions used in the activities of the Social Insurance Institution (ZUS) as an e-administration and their use during the COVID-19 pandemic. The trends emerging in response to the challenges in the transportation industry are highlighted in Dorota Zimnoch’s article entitled *“Digital Transformation of Transportation in the Age of COVID-19”*. An important problem is also the impact of the pandemic on education, as analyzed in the article by Tomasz Eisenhardt *“Virtual Learning Environments as a Remedy for Universities Against the COVID-19 Pandemic Crisis”*. From the technological perspective, this topic is discussed in the article entitled *“Cloud Communications During the Pandemic From the Perspective*

of *Collaboration Platforms*” by Joanna Kubacz-Szumaska and Oskar Szumski. Their research focuses on the identification of communication patterns prior and after COVID-19 was announced and the approach to the choices that end users make in relation to their preferred Unified Communication and Collaboration (UCC) platforms used in various aspects of life. Technological issues also appear in the presentation of a new digital technology – DARQ (Distributed Ledger, Artificial Intelligence, Extended Reality, Quantum) that can help overcome global crises during the COVID-19 period and that is addressed in the article by Jerzy Kisielnicki and Jan Zadrożny “*DARQ Technology as a Digital Transformation Strategy in Terms of Global Crises*”. The impact of the pandemic on the shaping of negative social attitudes is, in turn, discussed by Tomasz Parys in his article “*Fake News as a Barrier in the Process of Communicating Information*”. The field that has not changed much during the pandemic is depicted in the article by Damian Dziembek, entitled “*Integrated ERP-Class Management Information Systems – Evolution, Current State and Development Directions*” and presenting the state and development of integrated systems during the pandemic and their prospects thereafter.

On behalf of the authors, we would like to express the hope that this publication reveals an up-to-date view on the current problems involved in using information technologies as the latter develop during the coronavirus pandemic. It should offer practitioners new information on the issues discussed herein and inspire them to solve the problems of the contemporary world. For the world of science, it may turn out to be a motivation, a clue, and perhaps even a reason for undertaking new research in this area, which is very broadly outlined in this Introduction. We count on their future cooperation, even when only a mere memory remains after the current crisis.

This publication might provide the necessary knowledge and enable a better understanding of the “ICT reality” that surrounds us, while also being useful for students of economic and technical faculties at those universities where IT-related subjects and applications are taught.

In this spirit and with this conviction, we are presenting “Management Issues” No. 3/2021, which is the result of the intellectual efforts of the authors, to be finally judged by the readers. We are open to discussing the matters addressed herein and expect polemical or even critical voices as to the content and shape of future publications in this area. In the coming years, such voices will allow us to improve our work techniques and to better provide readers with the knowledge necessary for the proper functioning in a complex reality increasingly dominated by information technology, especially in crisis times.

We also wish to thank the reviewers for their valuable comments that have largely contributed to the final shape of this Issue.

On behalf of the Editors
Witold Chmielarz

Od redaktorów naukowych

Zdawać by się mogło, że na początku 2020 roku informatyka i jej różnorodne aplikacje w dostatecznym, a nieuciążliwym stopniu powoli opanowują wszelkie sfery działalności człowieka, zarówno te związane z pracą, jak i szeroko pojętą rozrywką, dominująco zaznaczając się w rozpowszechnianiu informacji oraz kontaktach międzyludzkich. Żaden kryzys nie mógł tej powolnej a pozytywnej, choć nieco sennej tendencji zagrozić. Nikt jednak nie przewidział ani pandemii koronawirusa COVID-19, ani światowego kryzysu, który ta pandemia spowodowała.

Czas zarazy stworzył idealne warunki dla przyspieszonego rozwoju elektronicznego, zdalnego handlu, rozrywki, zdalnej nauki oraz rozwoju dziedzin je wspomagających, takich jak np. dostawy. Znaczące ograniczenie bezpośrednich kontaktów międzyludzkich, „przypisanie” do miejsca pobytu, izolacja osób podejrzanych o chorobę, ograniczenia w poruszaniu się lokalnie i międzynarodowe, zakaz wstępu do lasów, zabytków kultury itp. absurdalnie głęboko, a wynikające z bezsilności władzy wobec pandemii i hipokryzji wobec członków własnych społeczności wpasowują się w klimat sprzyjający rozwojowi wszystkiego co „sieciowe”.

Pojawia się jednak pytanie: czy aby na pewno ten sprzyjający klimat właściwie i efektywnie jest wykorzystywany i czy rzeczywiście jest on w stanie w jakikolwiek sposób nawet nie zastąpić, ale przynajmniej stać się zaliczką normalności? Czy oswojenie w skali społecznej posługiwania się środkami zdalnej komunikacji i platformami kontaktów jest w jakikolwiek sposób zdolne zastąpić mechanizmy społeczne kształtowane przez stulecia? Czy jest tylko potrzebne władzom politycznym, korporacyjnym i administracyjnym wszystkich szczebli do podporządkowania sobie społeczeństw i testowania ich cierpliwości w przedłużaniu tego procesu? Jaka jest rola i miejsce technologii informacyjnych w tych procesach? Czy rzeczywiście powodują pogłębianie zjawiska globalizacji w opinii publicznej, czy wręcz przeciwnie – ujawniają przy okazji najniższe ludzkie przywary?

Pytania są poważne, na krawędzi egzystencjonalizmu (skąd przyszliśmy, gdzie jesteśmy, dokąd idziemy?). Czy wolność w ujęciu sieciowym to przejaw szeroko pojętego człowieczeństwa, czy tylko przejaw jego stosunku do nowoczesnej techniki? Czy rzeczywiście w tym przypadku można w ogóle mówić o wolności, a więc jeszcze o człowieczeństwie? I jakie są implikacje ekonomiczne, organizacyjne, kulturowe?

Obawiam się jednak, że niniejszy numer „Problemy Zarządzania” nie jest w stanie ich rozwiązać. Nad rolą technik informacyjnych w rozwoju

społeczeństw – zwłaszcza w okresie kryzysów: ekonomicznych, politycznych, biologicznych, klimatycznych i innych można i należy prowadzić wieloletnie pogłębione badania.

Dlatego dyskusja na ten temat jest ważna i wydaje się, że zamieszczone w tym numerze artykuły spełniają przynajmniej ten warunek – są na gorąco ujętymi bieżącymi relacjami z badań dotyczących roli informatyki w czasie pandemii COVID-19. Pewna ich „chropowatość” wynika właśnie z tego bieżącego, szybkiego ujęcia rzeczywistości, są też swoistym przeglądem dziedzin i problemów, w których wpływ COVID-19 jest najbardziej widoczny.

Prezentowany numer składa się z jedenastu merytorycznych artykułów, w większym lub mniejszym stopniu dotyczących problemów związanych z obecną pandemią koronawirusa COVID-19.

Rolę wprowadzającego w problematykę technologii informacyjnych w czasie pandemii COVID-19 odgrywa artykuł autorstwa Jolanty Wartini-Twardowskiej, Dariusza Grabary i Ewy Ziemy z tytułowany *The Influence of the COVID-19 Pandemic on the Use of Digital Technologies by Scientists: A Comparison Between Poland and Abroad*, mający na celu wskazanie trwałych różnic w częstotliwości wykorzystywania technologii cyfrowych przez naukowców do wspomagania badań w okresach przed, podczas i po pandemii koronawirusa. Ta najszersza perspektywa czasowa pozwala też na spojrzenie z dystansem na szerokie spektrum dziedzin, na które wpłynęła obecna sytuacja kryzysowa.

Podobną perspektywę prezentuje tekst Dariusza Grabary *Influence of the COVID-19 Pandemic on the Vignette Factors of Smartphone Auctions on the Allegro Auction Platform* koncentrujący się na zmianach użycia czynników prezentacji aukcji na liście aukcji na platformie sprzedażowej Allegro. Badanie to, podobnie jak poprzednie, wykonane zostało w trzech punktach czasowych przyjętych jako początek, centrum oraz okres po jej ustaniu.

Temat e-commerce w relacji do jego wpływu na globalizację i wpływu pandemii na jego przyspieszenie porusza artykuł Witolda Chmielarza, Marka Zborowskiego i Alicji Fandrejewskiej pt. *The Impact of the Pandemic (COVID-19) on Globalization – The Perspective of Electronic Commerce*.

Artykułem odnoszącym się do usług finansowych przed i w trakcie pandemii jest tekst Gertrudy Uścińskiej pt. *ICT Solutions in the Activities of the Social Insurance Institution (ZUS) as an E-Administration. Evolution During the COVID-19 Epidemic (Case Study)* przedstawiający ewolucję wybranych rozwiązań opartych na technologiach informacyjno-komunikacyjnych (ICT), wykorzystywanych w działalności Zakładu Ubezpieczeń Społecznych (ZUS) jako e-urzędu i ich wykorzystanie w czasie epidemii COVID-19.

W artykule Doroty Zimnoch z tytułowanym *Digital Transformation of Transportation in the Age of COVID-19* poddano natomiast analizie trendy pojawiające się w odpowiedzi na wyzwania branży transportowej w okresie pandemii.

Istotnym problemem jest również wpływ pandemii na sferę edukacji analizowany w artykule Tomasza Eisenbardta pt. *Virtual Learning Environments as a Remedy for Universities Against the COVID-19 Pandemic Crisis*.

Od strony technologicznej podchodzą zaś do tej tematyki Joanna Kubacz-Szumaska oraz Oskar Szumski w artykule pt. *Cloud Communications During the Pandemic From the Perspective of Collaboration Platforms*. Ich badania koncentrują się na identyfikacji wzorców komunikacyjnych przed i po ogłoszeniu pandemii COVID-19 oraz podejściu do wyborów dokonywanych przez użytkowników końcowych w odniesieniu do preferowanych platform Unified Communication and Collaboration (UCC) używanych w różnych aspektach życia.

Kwestie technologiczne pojawiają się również w zaprezentowanej w artykule Jerzego Kisielnickiego oraz Jana Zadrożnego pt. *DARQ Technology as a Digital Transformation Strategy in Terms of Global Crises* nowej technologii cyfrowej DARQ (Distributed Ledger, Artificial Intelligence, Extended Reality, Quantum).

Wpływem pandemii na kształtowanie się negatywnych postaw społecznych zajmuje się zaś Tomasz Parys w artykule *Fake News as a Barrier in the Process of Communicating Information*.

Dziedzinę, która niewiele zmieniła się w okresie pandemii ukazuje natomiast artykuł Damiana Dziembka zatytułowany *Integrated ERP-Class Management Information Systems – Evolution, Current State and Development Directions*, przedstawiający stan i rozwój systemów zintegrowanych w czasie pandemii i ich perspektywy po pandemii.

W imieniu Autorów pragniemy wyrazić nadzieję, że zaprezentowana pozycja wydawnicza jest wyrazem aktualnego spojrzenia na istniejące obecnie problemy zastosowania technologii informacyjnych w kontekście ich rozwoju w czasie pandemii koronawirusa. Przedstawicielom praktyki niniejsza praca powinna zaoferować nowe wiadomości na temat omawianych zagadnień i stanowić inspirację do rozwiązywania problemów świata współczesnego. Dla świata nauki okazać się motywacją, wskazówką, a być może nawet przyczyną podjęcia nowych badań w tym jakże szeroko zarysowanym na wstępie zakresie.

Wydaje się, że lektura niniejszego numeru dostarczy potrzebnej wiedzy oraz umożliwi lepsze poznanie otaczającej nas „rzeczywistości ICT”, jak również będzie przydatna studentom kierunków ekonomicznych i technicznych tych uczelni, w których wykładane są przedmioty związane z informatyką i jej zastosowaniami.

W tym duchu i przekonaniu oddajemy ten numer „Problemów Zarządzania”, będący efektem intelektualnego trudu Autorów pod ostateczny osąd Czytelników. Jesteśmy otwarci na dyskusję nad poruszonymi zagadnieniami i oczekujemy na głosy polemiczne czy nawet krytyczne, co do zawartości i kształtu przyszłych publikacji w tym zakresie. Pozwolą nam one bowiem w kolejnych latach udoskonalić nasz warsztat pracy oraz lepiej przekazywać

Czytelnikom wiedzę niezbędną do prawidłowego funkcjonowania w złożonej rzeczywistości zdominowanej w coraz większym stopniu przez technologię informacyjną, zwłaszcza w okresach kryzysowych.

Pragniemy wyrazić także podziękowania Recenzentom za cenne uwagi, które w dużym stopniu przyczyniły się do ostatecznego kształtu niniejszej publikacji.

W imieniu Redaktorów
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The Influence of the COVID-19 Pandemic on the Use of Digital Technologies by Scientists: A Comparison Between Poland and Abroad

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Abstract

Purpose: Our research was performed to identify differences in the frequency of using digital technologies by scientists to support their research in the periods before, during, and after the COVID-19 pandemic. **Design/methodology/approach:** A survey questionnaire was used and data were collected from 467 scientists from Poland and abroad, which were statistically analyzed. The non-parametric Kruskal–Wallis test was applied to reveal the differences in the frequency of digital technologies use between scientists in Poland and abroad in three periods (before, during, and after the COVID-19 pandemic). The non-parametric Friedman rank test and the post-hoc Conover test with Benjamini–Hochberg adjustment were used to assess the significant differences between three paired periods: before-during, before-after, and during-after the COVID-19 pandemic. For these periods, the association between the use of digital technologies and the types of research (basic or applied) conducted by scientists in Poland and abroad was also measured using Spearman’s rank correlation.

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Findings: Scientists from Poland and abroad differed in the use of all digital technologies before and after the COVID-19 pandemic. During the pandemic, the differences concerned only social media, owing to a similar increase in the use of both communication applications and e-learning platforms. The results demonstrated that there was a weak positive correlation between the use of all digital technologies and applied research by both groups of scientists for all paired periods. In Poland in particular, our research has confirmed a positive correlation between the use of communication applications and social media and basic research for two paired periods: before-during and during-after the pandemic.

Research limitation/implications: The limitations of this study were primarily related to the sample size, which did not allow the results to be generalized to the entire population. Another limitation was that all scientists from outside Poland were assigned to one group, without division into countries or regions of the world. This, however, enabled the research scope to be narrowed and resulted in stressing the differences between Poland and the rest of the world. A further limitation that may affect the research results is the adopted 5-point Likert scale, which determines the possibility of making an analysis.

Originality/value: This research contributes to knowledge about the adaptation of scientists in Poland and abroad to new conditions resulting from the COVID-19 pandemic regarding the frequency of digital technology use in basic and applied research. The significant differences found in the frequency of digital technology use between the three paired periods (before-during, before-after, and during-after the pandemic) have the potential to encourage research into their permanence.

Keywords: COVID-19 pandemic, digital technologies, scientific research, scientists.

JEL: D8, I23, O39

Wpływ pandemii COVID-19 na użycie technologii cyfrowych przez naukowców: Porównanie Polski z zagranicą

Streszczenie

Cel: nasze badanie zostało przeprowadzone w celu zidentyfikowania różnic w częstotliwości korzystania z technologii cyfrowych przez naukowców do wsparcia ich badań w okresach przed, podczas i po pandemii COVID-19.

Metodologia: wykorzystano kwestionariusz ankietowy i zebrano dane od 467 naukowców z Polski i zagranicy, które poddano analizie statystycznej. Zastosowano nieparametryczny test Kruskala–Wallisa, aby wykazać różnice między naukowcami w Polsce a za granicą w częstotliwości korzystania z technologii cyfrowych w trzech okresach (przed, podczas i po pandemii COVID-19). Nieparametryczny test rang Friedmana i test post-hoc Conovera z korektą Benjaminiego Hochberga wykorzystano do stwierdzenia istotnych różnic między trzema parami okresów: przed-podczas, przed-po i podczas-po pandemii COVID-19. Dla tych okresów zmierzono również, za pomocą korelacji rang Spearmana, związek między wykorzystaniem technologii cyfrowych a badaniami (podstawowymi lub stosowanymi) przeprowadzonymi przez naukowców w Polsce i za granicą.

Wyniki: naukowcy z Polski i zagranicy różnili się stopniem wykorzystania wszystkich technologii cyfrowych przed i po pandemii COVID-19. Podczas pandemii różnice dotyczyły jedynie mediów społecznościowych z powodu podobnego wzrostu wykorzystania zarówno aplikacji komunikacyjnych, jak i platform e-learningowych. Wyniki wykazały, że istnieje słaba pozytywna korelacja pomiędzy wykorzystaniem, przez obydwie grupy naukowców, wszystkich technologii cyfrowych a badaniami stosowanymi we wszystkich parach okresów. Zwłaszcza w Polsce nasze badania potwierdziły pozytywną korelację pomiędzy wykorzystaniem aplikacji komunikacyjnych i mediów społecznościowych a badaniami podstawowymi w dwóch parach okresów: przed-podczas i podczas-po pandemii.

Ograniczenia/implikacje badawcze: ograniczenia tego badania dotyczyły przede wszystkim wielkości próby, co nie pozwoliło na uogólnienie wyników na całą populację. Kolejnym ograniczeniem było zakwalifikowanie wszystkich naukowców spoza Polski do jednej grupy, bez podziału na kraje lub regiony świata. Umożliwiło to jednak zawężenie zakresu badań i zaowocowało podkreśleniem różnic między Polską a resztą świata. Kolejnym ograniczeniem, które może mieć wpływ na wyniki badań jest przyjęta 5-stopniowa skala Likerta determinująca możliwość dokonania analizy.

Oryginalność/wartość: badania te przyczyniają się do poszerzenia wiedzy na temat adaptacji naukowców w Polsce i za granicą do nowych warunków wynikających z pandemii COVID-19 w zakresie częstotliwości wykorzystania technologii cyfrowych w badaniach podstawowych i stosowanych. Stwierdzone różnice dotyczące częstotliwości korzystania z technologii cyfrowej w trzech sparowanych okresach (przed-podczas, przed-po i podczas-po pandemii) mogą potencjalnie zachęcić do zbadania ich trwałości.

Słowa kluczowe: pandemia COVID-19, technologie cyfrowe, badania naukowe, naukowcy.

1. Introduction

The COVID-19 pandemic has disrupted traditional modes of scientific communication (Bottanelli et al., 2020), and digital technologies have aided in building new working conditions. Particularly, the pandemic has accelerated an unprecedented shift in the extent to which personal interactions have been replaced by virtual interactions (Fink, 2020). Scientists are no strangers to rapid digital evolution, but they did not anticipate the online revolution, where most interactions now take place (Fink, 2020). At the same time, opportunities and challenges have emerged that have created a naturally occurring research gap regarding the use of digital technologies by scientists. Since the success of scientists depends on the type of research conducted (Bekkers & Bodas Freitas, 2008), we attempted to determine the impact of the COVID-19 pandemic on the use of communication applications, e-learning platforms, and social media in regard to the work of scientists in the context of their research (basic and applied). Per OECD (1993), basic research is defined as “research carried out for the advancement of knowledge, without working for long-term economic or social benefits and with no positive efforts being made to apply the results to practical problems or transfer the results to sectors responsible for its application.” In turn, applied research is defined as “original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.” (OECD, 2012).

In our study, we attempted to answer the main research question (RQ1):

RQ1: Has the COVID-19 pandemic changed the use of digital technologies in scientific research by scientists in Poland and abroad?

Before the COVID-19 pandemic, exploiting new digital technologies was one of the greatest challenges faced by organizations and many did not keep up with the new digital reality (Hess et al., 2016). The pandemic has brought changes; our research highlights the differences in digital technology use by university researchers in three paired periods (before-during, before-after, and during-after the COVID-19 pandemic).

RQ1 was supported by three hypotheses, which are listed in the third section of this article. We have organized the rest of this article as follows: section 2 describes a systematic literature review; section 3 contains research methodology and data analysis; discovered changes in observed analysis periods are described in section 4; section 5 includes discussion and conclusions.

2. Systematic Literature Review

We conducted a qualitative analysis of publications dating from 2019 to 2020 to investigate the impact of the current COVID-19 pandemic on scientific research and scientists (researchers). The download of data from the Web of Science Core Collection database was completed on November 1, 2020. Based in part on Centre for Reviews and Dissemination (CRD) (2008) and qualitative meta-synthesis of publications, we proposed the following five steps for the process of systematic review:

- (1) Preparation of research topics that included issues from the widest to the narrowest of the following: researcher AND Covid-19; scientists AND Covid-19 AND effects; academic* AND research* AND Covid-19* AND digital*; academic AND research AND Covid-19 AND media; academic* AND staff AND activit* AND Covid-19.
- (2) Searches of the Web of Science Core Collection citation and chemical indexes of all publications (949 in total) that included the following issues: researcher AND Covid-19 (842); academic* AND staff AND activit* AND Covid-19 (14); scientists AND Covid-19 AND effects (45); academic* AND research* AND Covid-19* AND digital* (20); academic AND research AND Covid-19 AND media (28). The indexes used were as follows: Science Citation Index Expanded (SCI-EXPANDED), 1900–present; Social Sciences Citation Index (SSCI), 1900–present; Arts & Humanities Citation Index (A&HCI), 1975–present; Conference Proceedings Citation Index-Science (CPCI-S), 1990–present; Conference Proceedings Citation Index-Social Science & Humanities (CPCI-SSH), 1990–present; Book Citation Index-Science (BKCI-S), 2010–present; Book Citation Index-Social Sciences & Humanities (BKCI-SSH), 2010–present; Emerging Sources Citation Index (ESCI) 2015–present; Current Chemical Reactions (CCR-EXPANDED), 1985–present (includes Institut National de la Propriete Industrielle structure data from 1840); Index Chemicus (IC), 1993–present.
- (3) Exclusion of publications that were duplicated, discussions, editorials, letters, book reviews, posters, or did not explicitly fulfill the following criteria: English language, existing abstract, usage of one of the above-named terms; academic nature of peer review, and access to a complete publication.

- (4) Qualification of data after having reviewed the remaining 914 papers. We excluded 905 that did not relate to researchers or scientists and their research, and those with inadequate content. We retained papers that included the use of digital technologies for research purposes, except for research on the spread of the COVID-19 virus or other related medical issues.
- (5) Analysis and (narrative) synthesis using the full text of the final set of extracted publications, and a comparison of the extracted publications using a synthetic description (see Table 1). Based on in-depth analysis, we concluded that four of the nine extracted articles related directly to the usage of digital technologies, while the remaining articles only tangentially referred to it. Byrnes et al. (2020) compiled a list of video conferencing technologies, software, and online platforms to support anatomists' communication and collaboration, which highlighted the advantages and disadvantages of video conferencing technology in teaching and research. In turn, according to Davison (2020), using digital technologies to collect data during the COVID-19 pandemic is merely replication, and a more effective way to meet respondents is required in the context of social science research realization. In the opinion of Kligler-Vilenchik et al. (2020), social media has become a way of spending time during the COVID-19 pandemic for most (non-scientist) respondents. However, Schwarz et al. (2020) explored digital formats of interaction between research community members that became part of a new regime of academic exchange. Interactions between scientists due to digital technologies have increased the integrity of knowledge exchange, and have reduced the time and costs of organizing interactions that are geographically and temporally differentiated (Trogisch et al., 2020). A somewhat similar research direction was chosen by Bottanelli et al. (2020) suggesting a set of practices for creating a series of effective online seminars, and Weissberger et al. (2020) provided ideas for organizing virtual conferences with live video, chats, and social media.

Author (year)	Research method	Field of sciences	Period of research	Context or formulated key research questions	Findings or recommended research questions
1	2	3	4	5	6
Bottanelli et al. (2020)	Multi-case research	Natural Sciences	During COVID-19	Virtual research seminars: adoption of new ways to communicate science and build scientific relationships within a digital environment	<ol style="list-style-type: none"> (1) Set of practical suggestions to create an online seminar series for research communities such as: <ol style="list-style-type: none"> (i) confirm interest in the topics of seminars based on surveying social media as well as through national or international scientific societies (ii) synergize with organizers of other seminars without competing with an existing seminar series (iii) consider a brand for seminars (iv) develop the content of seminars based on safe speakers (v) promote speakers (2) Find new ways to communicate science and build scientific relationships in the context of a digital environment (3) Provide advice on formats and tools, security, spreading the word, and creating a diverse, inclusive or collegial space online
Byrnes et al. (2020)	Narrative review	Medical and Health Sciences	During COVID-19 and after	The utility of communication technologies, social media, and three-dimensional digital animation technology in supporting effective communication and professional activities of anatomists	Highlighted the need for further improvements in communication technologies to improve dependability, costing, and audio-visual quality
Davison (2020)	Narrative review	Social Sciences	During COVID-19	The nature of COVID-19's disruption and ways a researcher, teacher, administrator, and editor deal with it	Data collection through IT technology during COVID-19 is only replication
Fink (2020)	Literature review	Social Sciences	During COVID-19	<ol style="list-style-type: none"> (1) Opportunities and challenges for information systems research areas and methodologies (2) The current landscape of the research community 	<ol style="list-style-type: none"> (1) The suggestion of investigating research areas such as: <ol style="list-style-type: none"> (i) remote work (particularly from home) (ii) virtual collaboration (the digitization of physical collaboration), especially the effects of more varied contingencies on performance in collaborative settings (iii) distance learning: its efficiency and variance, as well as new avenues (iv) digital infrastructure (evolution of digital infrastructure and streaming quality) (2) Difficulties, due to COVID-19 disruption, for social scientists in using pre-pandemic findings when formulating hypotheses and making predictions, or developing new conceptualizations
Kligler-Vilenchik et al. (2020)	Two waves of the 10-day survey of salient Twitter users in Jerusalem (March 9–March 19, N = 34; March 23–April 2, N = 25) Online questionnaire-based survey Mixed-methods analysis	Social Sciences	During COVID-19	<ol style="list-style-type: none"> (1) The methodological challenges of adapting ongoing academic survey studies to a changing environment (2) How social media use—and academic research—evolve during times of global pandemic 	The increased use of Twitter as a way to pass time — a phenomenon rather uncommon in “traditional” crises such as natural disasters
Schwarz et al. (2020)	Narrative review	Social Sciences	During COVID-19	Digital workplaces for researchers	<p>Digital interaction formats:</p> <ol style="list-style-type: none"> (i) increase the inclusivity of knowledge exchange, reduce time and costs of organizing academic interactions (ii) enable more diverse workspaces with geographical and temporal flexibility (iii) struggle to reproduce social interactions such as informal discussions (iv) raise new concerns on data security (v) could induce higher stress levels

Table cont.

Author (year)	Research method	Field of sciences	Period of research	Context or formulated key research questions	Findings or recommended research questions
1	2	3	4	5	6
Trogisch et al. (2020)	Single-case research: Sino-German international research training group dedicated to early-career researchers	Natural Sciences	During COVID-19 and after	The Sino-German international collaborative research program	Five pillars for the resilience of large international collaborative research programs: (i) flexible funding and reporting deadlines (ii) a guarantee of the continuation of research through a fallback plan adaptation and its implementation (iii) innovation in teaching and the supervision or mentoring, as well as promoting learning motivation (iv) intensification of assurances about continuous support and help in case of mental health problems (v) intensification and integration of team members thanks to regular online meetings and virtual seminars for creative and successful teamwork (2) Opportunities and threats of international collaboration
Utoft (2020)	Narrative review Single-case research	Social Sciences	During COVID-19	(1) Myth about “the single woman” as an academic—a future spurious star in pandemic times and her academic productivity (2) Research questions: (i) when does work–life balance mean work–family balance? (ii) can there be a “life” for “the single, childfree female academic” if work is the only thing left?	Proposed activities to prevent disclusion: (i) great solidarity and encouragement thanks to online communities and writing groups with strangers; (ii) daily, virtual 11-o’clock coffee break with colleagues; (iii) inspiration coming from the radically honest, unapologetic, active writers who tell unpolished stories of their struggles and overcoming them during the COVID-19 pandemic
Weissgerber et al. (2020)	Narrative review	Medical and Health Sciences, Natural Sciences	During COVID-19	Repercussions of a lockdown on work and wellbeing for UK doctoral students and early-career researchers	(1) Seven recommendations to mitigate the unintended consequences of conference and travel cancellations (2) A list of ideas for virtual conferences

Tab. 1. Literature about the impact of the COVID-19 pandemic on scientists and their scientific research. Source: The authors' elaboration.

3. Research Methodology

The research problem described in this paper is part of broader research that aims to collect opinions on how the COVID-19 pandemic has changed scientific research and educational processes, especially regarding the adoption of different digital technologies. A quantitative research approach was adopted and a questionnaire survey was conducted in this study. The research process is documented in detail below, with a focus on addressing the main research problem of this paper, answering the specific research questions posed, and testing the hypotheses formulated.

3.1. Research Instrument

A survey questionnaire written in English was developed for collecting empirical data from academics in Poland and abroad. We used the same version of the survey questionnaire in all countries. We decided not to design or translate the questionnaire in Polish (or other languages) to avoid inconsistencies and inaccuracies in some expressions due to translation.

The survey questionnaire aimed to collect opinions on how the pandemic has changed educational processes and scientific research, especially regarding the use of different forms of digital technologies. It was composed of four parts. We began by explaining the research aims and informed respondents that their participation in completing the survey was voluntary. It was also guaranteed that all responses would be kept confidential. The first section of the questionnaire included questions on demographic information (gender, age, citizenship), professional information (position type, research discipline), and type of university (traditional, online). The second section contained questions on how respondents' work hours were allocated to different activities before, during, and after the COVID-19 pandemic, and the predicted changes in future publication and funding related to spending on research, teaching, and writing before, during, and after the pandemic. The third section was related to the teaching process, regarding the quality and support of digital technologies, before, during, and after the COVID-19 pandemic. The final section included questions on scientific works and the quality and support of digital technologies before and during the pandemic, as well as its implications on these issues in the future. At the end of the questionnaire, we asked respondents about their forecasts for the future of research and education after the COVID-19 pandemic.

The survey respondents answered the following five questions (QQ):

- QQ1:** How much is your research focused on basic research in science, before, during, and after the coronavirus pandemic?
- QQ2:** How much is your research focused on applied research in science, before, during, and after the coronavirus pandemic?

- QQ3:** How do you assess the frequency of usage of any communication apps in your research, before, during, and after the coronavirus pandemic (e.g., Skype, WhatsApp, Messenger, MS Teams)?
- QQ4:** How do you assess the frequency of usage of any e-learning platforms in your research before, during, and after the coronavirus pandemic (e.g., Moodle, Google Classroom, Zoom, Docebo, Wizz IQ, ATutor)?
- QQ5:** How do you assess the frequency of usage of any social media in your teaching and education, before, during, and after the coronavirus pandemic (e.g., Facebook, Twitter, LinkedIn, YouTube, Instagram, blog sites)?

We used a 5-point Likert scale for the respondents' assessments. They answered the first two questions as follows: (1) never, (2) seldom, (3) sometimes, (4) often, and (5) very often. For the next three questions, respondents could choose one of five responses: (1) definitely unimportant, (2) rather unimportant, (3) neither important nor unimportant, (4) rather important, and (5) definitely important.

To verify the draft version of the survey questionnaire, a pilot study was conducted with 17 academics from Poland and abroad (two from the UK and United States each, one each from Slovakia, Germany, and Nigeria, and 10 from Poland) at the end of May 2020. As a result, a few questions were deleted, and minor changes of a formal, technical, or language nature were made to others. An improvement in the questionnaire layout was made but no substantive amendments were required.

3.2. Research Subjects

Selecting a sample is a fundamental element of a quantitative study (Collis & Hussey, 2003). Stratified sampling was used to obtain the sample, which can be taken to be true for the whole population. The strata were identified based on country, age, gender, position type, and research discipline. To gather a substantial number of respondents, snowball sampling was pursued, which involved daily and routine distribution (social media and email posting) of an introduction e-letter and survey link requesting participation in the research. To increase response rates, the following methods described by Nulty (2008) were used: involving academics (encouraging colleagues), pushing the survey (providing respondents with the survey URL in emails sent directly to them), publishing the project with a link to the basic questionnaire on the ResearchGate website (www1) and Facebook fan pages, and providing frequent reminders.

3.3. Data Collection

Based on several analyses showing that surveys conducted over the internet provide results that are as valid as more "traditional" methods

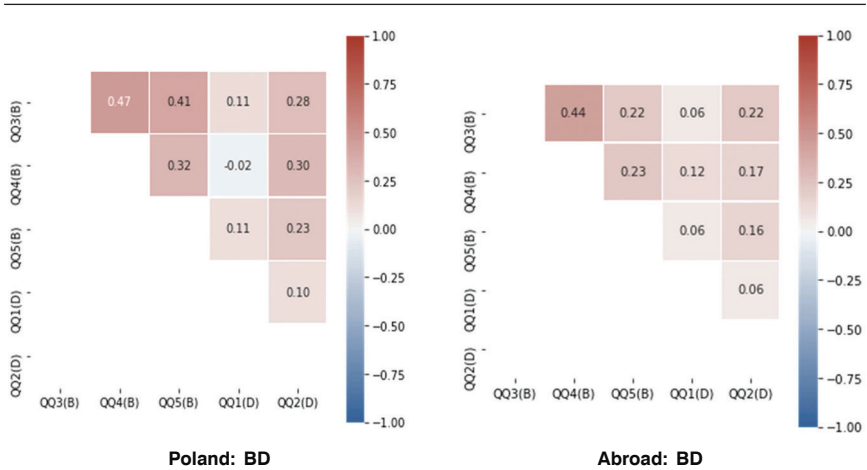
(Shatz, 2017), and due to social distancing because of the pandemic, we used the Computer Assisted Web Interview method for recruiting respondents and collecting data. The LimeSurvey tool was employed for recruiting reliable samples. The data were collected during two months of work, from June 11 to August 18, 2020. This led to 982 responses. After screening the responses and excluding outliers, 476 usable, correct, and complete responses were collected and subjected to further analysis. The demographic analysis of the research sample is presented in Table 2.

Characteristics	Demographic factors	Number of respondents	Percentage of respondents
Gender	Females	238	50.0
	Males	231	48.5
	Unspecified	7	1.5
Age	20–34	86	18.1
	35–49	228	47.9
	50–68	146	30.7
	>69	16	3.4
Country	Poland	278	58.4
	Abroad	198	41.6
Position type	Graduate student in doctoral program	52	10.9
	Lecturer	53	11.1
	Assistant Professor	143	30.0
	Associate Professor	123	25.8
	Professor	86	18.1
	Retired	4	0.8
	Other: Assistant and researcher	15	3.2
Research discipline	Social sciences	382	80.3
	Engineering and technology	65	13.7
	Humanities	13	2.7
	Natural sciences	14	2.9
	Medical and health sciences	1	0.2
	Agricultural sciences	1	0.2

Tab. 2. Demographic statistics of survey respondents. Source: The authors' research.

3.4. Data Analysis

The data were stored in different formats, for example, CSV. MS Excel. XML. We employed MS Excel to extract the relevant data. Using PS Imago Pro 6.0. (SPSS Statistics 26) and RStudio, the data were statistically analyzed. Firstly, Cronbach’s coefficient alpha was used to conduct reliability analysis. For the five analyzed questions on the questionnaire, Cronbach’s alpha was 0.840, which indicated high internal consistency and reliability (Hinton, Brownlow, McMurray, & Cozens, 2004). Secondly, descriptive statistical analysis was employed to assess the frequency of digital technology use. The following statistics were calculated: median; mode; coefficient of variance; skewness; and kurtosis using SPSS. Figure 1 was created using Python (version 3.7.0) (Twardowska, 2021). Thirdly, the Kruskal–Wallis test was applied to identify differences in the frequency of digital technology use in the research of scientists in Poland and abroad during the following periods: before (B), during (D), and after (A) the COVID-19 pandemic. Fourthly, the non-parametric Friedman rank test and Conover’s multiple comparison test were used to identify significant differences between the three paired periods BD, BA, DA. Fifthly, Spearman’s rank correlation coefficients were used to identify the association between the frequency of digital technology use and the type of research in both groups of scientists for the paired periods BD, BA, DA. Correlation coefficient values <0.3 were classified as weak; from 0.3 to 0.7 as moderate; and from 0.7 to 1 as strong correlations (Bland & Altman, 1995).



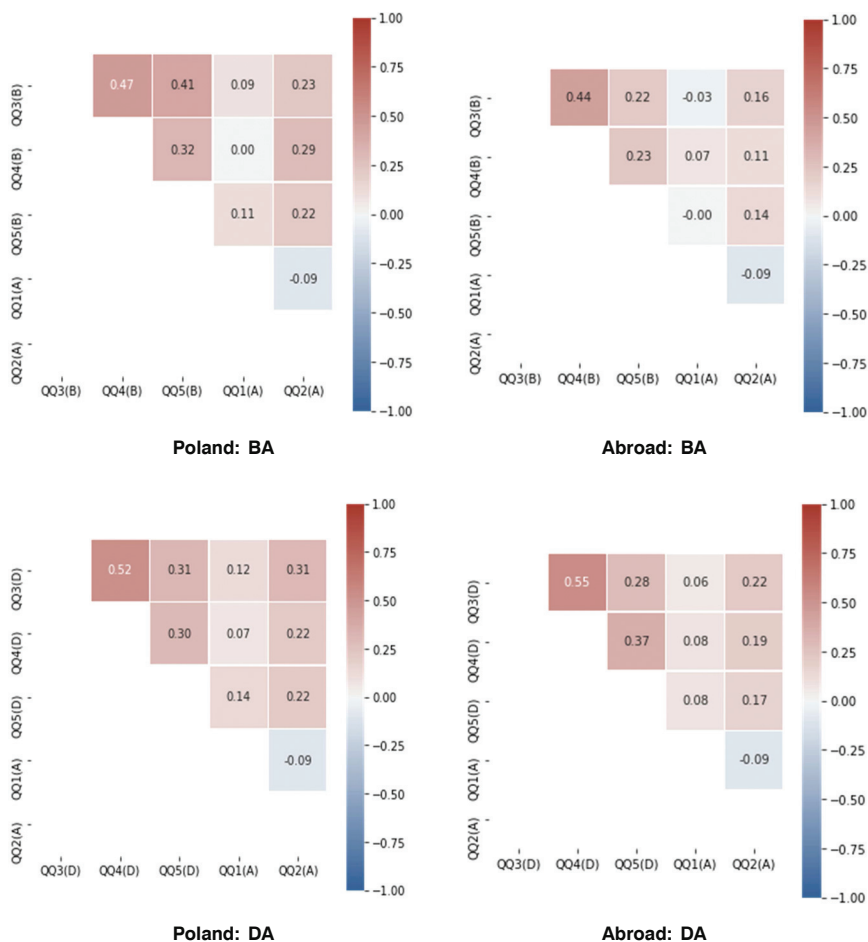


Fig. 1. Spearman's rho correlation coefficients between digital technologies and scientific research for the paired periods BD, BA, DA. Source: The authors' research.

Three hypotheses were formulated:

- H1:** There were significant differences in the frequency of digital technology usage by scientists in Poland and abroad to support their basic research for the paired periods: BD, BA, DA;
- H2:** There were significant differences in the frequency of digital technology usage by scientists in Poland and abroad to support their applied research for the paired periods: BD, BA, DA;
- H3:** There is a positive correlation between the frequency of digital technology usage by scientists and scientific research in Poland and abroad for the paired periods: BD, BA, DA.

4. Statistical Analysis

4.1. Reliability Measurement

The first stage of the analysis was the calculation of the internal consistency reliability of five dependent variables (QQ1–QQ5) for three periods B, D, A. It was based on Cronbach's coefficient alpha. The test results are presented in Table 3.

Cronbach's Alpha	Cronbach's Alpha based on standardized items	No. of items
0.84	0.84	15

Tab. 3. Reliability statistics. Source: The authors' research.

According to George and Mallery's rules of thumb (George & Mallery, 2003), Cronbach's $\alpha > 0.8$ indicated good internal consistency of the five assessed questions.

4.2. Descriptive Statistics

Table 4 shows the analysis outputs of survey questionnaires from SPSS involving three questions about digital technologies (QQ3–QQ5). Computed descriptive statistics included: median, mode, variance, skewness, and kurtosis. Respondents in Poland and those abroad were analyzed separately.

Items		Questions	QQ3 B	QQ3 D	QQ3 A	QQ4 B	QQ4 D	QQ4 A	QQ5 B	QQ5 D	QQ5 A
Poland	N	Valid	278	278	278	278	278	278	278	278	278
		Missing	0	0	0	0	0	0	0	0	0
	Median	2.00	4.00	4.00	2.00	4.00	3.00	2.00	2.00	2.00	
	Mode	2	5	4	1	5	4	1	1	1	
	Variance	1.21	1.50	1.09	1.49	2.29	1.64	1.21	1.88	1.67	
	Skewness	0.54	-1.07	-0.54	1.01	-0.73	-0.37	1.03	0.58	0.49	
	Kurtosis	-0.44	0.13	-0.15	-0.01	-1.00	-0.91	0.18	-0.98	-0.97	
Abroad	N	Valid	198	198	198	198	198	198	198	198	198
		Missing	0	0	0	0	0	0	0	0	0
	Median	3.00	4.00	4.00	2.00	4.00	4.00	3.00	3.00	3.00	
	Mode	3	5	4	2	5	4	3	4	4	
	Variance	1.04	1.39	0.90	1.54	1.90	1.41	1.24	2.04	1.76	
	Skewness	0.18	-1.23	-0.79	0.37	-0.96	-0.66	0.15	-0.10	-0.18	
	Kurtosis	-0.53	0.65	0.54	-0.92	-0.41	-0.40	-0.99	-1.34	-1.17	

Tab. 4. Descriptive statistics. Source: The authors' research.

QQ3: How do you assess the frequency of usage of any communication apps in your research (e.g., Skype, WhatsApp, Messenger, MS Teams)?

The median of the frequency of communication application usage by scientists in Poland changed from two (seldom) before the pandemic to four (often) during and after the COVID-19 pandemic. A similar increase of median occurred for scientists abroad over the same periods, but before the COVID-19 pandemic, the median was higher at three.

Most frequently, both groups of respondents used communication applications equally often during (Mode = 5: very often) and after the pandemic (Mode = 4: often), as opposed to before the pandemic (Mode = 2 for PL or Mode = 3 for abroad). The highest growth was during the pandemic. In the analyzed period, the variance was higher for Polish scientists than for scientists abroad, while it fluctuated in both groups of respondents.

Respondents in Poland and abroad were the most diverse in relation to communication application usage during (Variance = 1.50 for PL, Variance = 1.39 for abroad), and after the pandemic, the variance was the lowest. The skewness of communication application usage by scientists in Poland and abroad varied. During and after the pandemic, left-asymmetric skewness was observed, while right-asymmetric values were detected before the pandemic. Before and after the pandemic, the kurtosis for Poland was below zero (i.e., extreme values were greater), with a slightly higher variety before the pandemic. During the pandemic, the kurtosis focused on a positive value. For scientists abroad, the kurtosis was negative before the pandemic (B), whereas during and after the pandemic, a lower spread of values was observed.

QQ4: How do you assess the frequency of usage of any e-learning platforms in your research (e.g., Moodle, Google Classroom, Zoom, Docebo, Wizz IQ, ATutor)?

The median frequency of e-learning platform usage for scientists in Poland changed from the value of two (seldom) before, to four (often), and three (sometimes) after the pandemic. The median for scientists abroad also increased to four (often) during the pandemic and was sustained after the pandemic. In Poland and abroad, e-learning platforms were used more often during (Mode = 5: very often) and after (Mode = 4: often), than before the COVID-19 pandemic (Mode = 1 for PL or Mode = 2 for abroad), with the highest increase during the pandemic.

In the analyzed periods, the variance was higher for scientists in Poland than abroad, except for the period before the pandemic. The variance fluctuated positively for scientists in Poland compared to the period before the pandemic. During the pandemic, scientists in Poland and abroad were the most diversified in terms of the use of e-learning platforms (Variance = 2.29 PL, Variance = 1.90 abroad). In the post-pandemic period, the variance was even lower for scientists abroad than

before the pandemic. The skewness of the use of e-learning platforms for Polish scientists fluctuated. During and after the pandemic, left-asymmetric skewness was observed, as opposed to the right-asymmetric values that were viewed before the pandemic. Kurtosis values for scientists in Poland and abroad in all three periods B, D, and A were below zero, that is, extreme values increased in frequency, although they decreased gradually abroad.

QQ5: How do you assess the frequency of usage of social media in your research (e.g., Facebook, Twitter, LinkedIn, YouTube, Instagram, blog sites)?

The median frequency of social media use by scientists was the same throughout the analyzed periods B, D, A. The median frequency for scientists in Poland was lower (Median = 2, i.e., seldom) than for abroad (Median = 3, i.e., sometimes).

Most frequent respondents in Poland did not use and do not intend to use social media after the pandemic (Mode = 1, i.e., never). The most frequent response from respondents abroad regarding before the pandemic was „sometimes” (Mode = 3), and during and after the pandemic a positive change was observed (Mode = 4, i.e., often). In the analyzed periods, the variance was higher for scientists abroad than for Polish scientists.

Social media use fluctuated positively in Poland and abroad compared to the period before the pandemic. Scientists differed mostly on the use of social media during the pandemic (Variance = 1.88 for PL; 2.04 for abroad), although after the pandemic, the variance was still higher than before the pandemic. In the analyzed periods B, D, A, the skewness for scientists in Poland and abroad systematically decreased. However, in Poland the left-asymmetry of values above the mean in periods D and A decreased, while abroad the skewness was higher than zero before the pandemic, and due to the systematic decline of values in periods B, A turned into a negative skew. The kurtosis for Poland before the pandemic changed from right-asymmetry in the period B to left-asymmetry, and in period A it was almost the same as period D. The kurtosis for abroad was negative in all three periods, that is, extreme values increased in frequency, and the abundance curve was systematically flattening in periods B, D, A.

4.3. Analysis of the Differences Between Scientists in Poland and Abroad

The results for the Kruskal–Wallis test in Table 5 showed that:

- (a) before the COVID-19 pandemic, scientists in Poland and abroad were significantly different in:
- the use of communication applications in scientific research, QQ3 supported H1;
 - the use of e-learning platforms in scientific research, QQ4 also supported H1;

- (b) during the pandemic, scientists in Poland and abroad did not differ significantly in the use of communication applications and e-learning platforms in scientific research, QQ3, QQ4 did not support H1 for this period;
- (c) after the pandemic, scientists in Poland and abroad significantly differed in:
- the use of communication applications in scientific research, QQ3 supported H1;
 - the use of e-learning platforms in scientific research, QQ4 supported H1;
- (d) in all analyzed periods, Polish scientists were significantly different from scientists abroad in terms of the frequency of social media use, QQ5 supported H1.
- Polish scientists and scientists abroad differed in most of the analyzed periods in the frequency of specified digital technologies use.

Questions	Significance*	Decision	Questions	Significance*	Decision
QQ3 B	0.00	Reject the null hypothesis	QQ4 A	0.00	Reject the null hypothesis
QQ3 D	0.54	Accept the null hypothesis	QQ5 B	0.00	Reject the null hypothesis
QQ3 A	0.01	Reject the null hypothesis	QQ5 D	0.00	Reject the null hypothesis
QQ4 B	0.00	Reject the null hypothesis	QQ5 A	0.00	Reject the null hypothesis
QQ4 D	0.42	Accept the null hypothesis			

* Asymptotic significances are displayed.

Tab. 5. Non-parametric Kruskal-Wallis test (*k* independent samples). Source: The authors' research.

4.4. Analysis of the Differences Between Scientists in Poland and Abroad in Inter-Period Comparisons

The difference identified in the frequency of digital technologies use in each paired period (BD, BA, DA) was based on values in Table 6 involving (a) Friedman chi-squared; (b) df (number of points of freedom); and (c) p-value (the probability that the Friedman test accepts the value of F). The Conover test identified the significant differences between specific paired periods (BD, BA, DA) and included the Conover's statistics; p-value (probability of accepting the value of the test statistic by the Conover test); adj. p-value (equal probability of accepting the test statistic by the Conover test); the Benjamini-Hochberg method to counteract group risk.

Nationality	Item	QQ3	QQ4	QQ5	Item	QQ3	QQ4	QQ5	Nationality
Poland	N	278	278	278	N	198	198	198	Abroad
	Friedman Chi-Squared	358.91	301.97	111.24	Friedman Chi-Squared	234.45	210.92	109.56	
	df	2	2	2	df	2	2	2	
	p-value	0.00*	0.00*	0.00*	p-value	0.00*	0.00*	0.00*	

Note: * p-value $\leq \alpha$.

Tab. 6. Friedman rank test for differences between the paired periods BD, BA, DA. Source: The authors' research.

Statistically significant differences were found between the frequency of the use of communications applications and e-learning platforms in the paired periods BD, BA, DA, hence supporting the H2 hypothesis. However, owing to the lack of differences concerning the use of social media by Polish scientists in the period DA (Table 7), the H2 hypothesis was only partially supported. Scientists in Poland and abroad also differed in terms of the correlation between (basic or applied) research and the frequency of digital technologies use (Figure 1).

Nationality	QQ	Item	BD	BA	DA	Item	BD	BA	DA	QQ	Nationality
Poland	QQ3	N	278	278	278	N	198	198	198	QQ3	Abroad
		Conover's statistics	26.13	18.26	-7.88	Conover's statistics	20.64	16.07	-4.57		
		p-value	0.00*	0.00*	0.00*	p-value	0.00*	0.00*	0.00*		
		adj. p-value ¹⁾	0.00*	0.00*	0.00*	adj. p-value ¹⁾	0.00*	0.00*	0.00*		
	QQ4	N	278	278	278	N	198	198	198	QQ4	
		Conover's statistics	23.81	17.26	-6.55	Conover's statistics	19.51	15.41	-4.10		
		p-value	0.00*	0.00*	0.00*	p-value	0.00*	0.00*	0.01*		
		adj. p-value ¹⁾	0.00*	0.00*	0.00*	adj. p-value ¹⁾	0.00*	0.00*	0.01*		
	QQ5	N	278	278	278	N	198	198	198	QQ5	
		Conover's statistics	12.39	13.47	1.08	Conover's statistics	12.96	12.79	-0.17		
		p-value	0.00*	0.00*	0.73	p-value	0.00*	0.00*	0.99*		
		adj. p-value ¹⁾	0.00*	0.00*	0.73	adj. p-value ¹⁾	0.00*	0.00*	0.99*		

Note: QQ – questionnaire question; BD – before, during the COVID-19 pandemic; BA – before, after the COVID-19 pandemic; DA – during, after the COVID-19 pandemic; ¹⁾ p adjustment method – Benjamini-Hochberg method; * statistically significant value.

Tab. 7. Conover's test. Source: The authors' research.

4.5. Analysis of the Correlation Between Digital Technologies and Scientific Research

H3 was fully supported by the results of the analysis based on Spearman's rank correlation coefficients for Poland:

- (a) for the paired periods BD, BA: weak positive correlation between the frequency of the use of communication applications and social media, and applied research;
 - (b) for the paired period DA: (i) moderate positive correlation between the frequency of the use of communication applications and applied research, and (ii) weak positive correlation between the frequency of the use of e-learning platforms and social media, and applied research; and (iii) weak positive correlation between the frequency of the use of communication applications and social media, and basic research;
- Moreover, for scientists abroad:
- (a) for the paired periods BD, BA, DA: weak positive correlation between the frequency of the use of all digital technologies and applied research,
 - (b) for the paired period BD: weak positive correlation between the frequency of the use of e-learning platforms and basic research.

5. Conclusions and Discussion

The destructive nature of the pandemic has prompted scientists to frequently use digital technologies to solve research problems (Byrnes et al., 2020). Our research has confirmed that during and after the COVID-19 pandemic, scientists in Poland and abroad used digital technologies in their research more frequently than earlier.

Firstly, the examined scientists from Poland and abroad differed in the frequency of digital technologies use before the pandemic—more often digital technologies were used by the scientists from abroad. However, we did not find such differences between scientists in Poland and abroad in the use of communication applications and e-learning platforms during the COVID-19 pandemic. Moreover, their use during the pandemic increased to a similar level in both groups of scientists. Subsequently, we observed large differences in the use of social media by scientists in Poland and abroad—scientists from abroad used social media much more often during the pandemic and intend to continue after the pandemic.

Secondly, our research has confirmed that there were significant differences in the frequency of digital technology use by scientists in Poland and abroad in their research. Therefore, our research contributed toward identifying differences between the use of digital technologies in three paired periods: before-during, before-after, and during-after the pandemic. It also shows that we are getting closer to the next stage, that is, the permanence of these differences rather than a long-term adoption of modern communication tools, as concluded by Byrnes et al. (2020).

Thirdly, in the case of scientists abroad, we did not find a positive correlation between the use of the majority of digital technologies and basic research. Nevertheless, the correlation between the use of social media and applied research for scientists abroad was weaker than for Polish scientists, although in each of the analyzed periods, scientists abroad often or very often used social media.

In each paired period, a moderate correlation between the use of some digital technologies and application research was discovered only in Poland. We also identified a weak correlation between the use of communication applications (for two paired periods: before-during, and during-after the pandemic) and social media (for each paired period), and the basic research of scientists in Poland.

Overall, the results of our research support Ahmad's (2020) conclusion that the COVID-19 pandemic would change the world, and scientists should accept the permanent changes that allow them to reimagine themselves in a new reality (Utof, 2020).

Owing to the influence of the COVID-19 pandemic on an increase in the frequency of digital technology use, future research could focus on how digital technologies help to integrate research teams and establish collaboration, which in turn, might translate into the higher quality and a greater quantity of basic or applied research.

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Influence of the COVID-19 Pandemic on the Vignette Factors of Smartphone Auctions on the Allegro Auction Platform

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Abstract

Purpose: The influence of the COVID-19 pandemic on e-commerce sales has been perceived from different points of view. This study focuses on changes in the usage of auction vignette factors on one of the most successful sales platforms, Allegro, at three points in time during the pandemic, considered as the pre-pandemic, deep-pandemic, and post-pandemic state.

Design/methodology/approach: The research study uses 3 samples of offers – 320 for the 1st point in time, 259 for the 2nd point in time, and 303 for the 3rd point in time—in the category of Samsung S10 smartphones to determine the changes among the presentation factors belonging to the offers. 22 factors and 5 indexes were examined.

Findings: The results show substantial changes in the usage of factors such as shipping cost, the increased importance of “Buy Now” auctions, platform currency, and the decreased importance of “Bid” auctions. The indexes were also proposed in order to adopt a synthetic view of the factor groupings. The shipping index was pointed out as one factor that may be affected by the pandemic.

Research limitations/implications: The sampling technique limited the study to a preselected category of smartphones. The category was biased by the use of a non-category brand. Non-category items were removed from the data used. Other limitations include ambiguities involved in the assignment of the factors.

Originality/value: The contribution of this study is its examination of a frequently omitted area of factors that buyers use as a first choice when selecting an offer. The uniqueness of the study is covered by the point in time used in the study, i.e. deep-pandemic. Other points in time were based on the announcements of the government of Poland.

Keywords: e-commerce auction, sales platform, auction presentation factors, COVID-19 pandemic, auction vignette.

JEL: D44, D80, M30

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Wpływ pandemii COVID-19 na prezentacje aukcji smartfonów na platformie aukcyjnej Allegro

Streszczenie

Cel: wpływ pandemii COVID-19 na sprzedaż w ramach e-commerce jest postrzegany z różnych punktów widzenia. Przedłożony artykuł koncentruje się na zmianach użycia czynników prezentacji aukcji na liście aukcji na odnoszącej sukcesy platformie sprzedażowej Allegro. Badanie wykonane zostało w trzech punktach pandemii przyjętych jako początek, centrum oraz okres po ustaniu pandemii.

Konstrukcja/metodyka: badanie obejmuje trzy grupy ofert liczących 320, 259 i 303 obserwacji w kolejnych punktach pandemii w kategorii smartfonów Samsung S10. Zanalizowano 22 czynniki i 5 wskaźników.

Wyniki: otrzymane rezultaty wskazują na istotne zmiany w użyciu czynników, takich jak koszty dostawy, wzrost znaczenia aukcji „Kup Teraz”, waluty Allegro oraz spadek znaczenia aukcji z licytacją. Zaproponowano wykorzystanie syntetycznych wskaźników obejmujących grupy czynników. Zaobserwowano, iż wskaźnik kosztów dostawy może ulegać wpływowi pandemii.

Ograniczenia/implikacje badawcze: próba badawcza została ograniczona do kategorii smartfonów. W kategorii zanotowano istnienie towarów z innych kategorii. Dane zostały oczyszczone. Jako inne ograniczenie występuje niejednoznaczność przypisania czynników do wskaźników.

Oryginalność/wartość: często omijany obszar badań związanych z czynnikami prezentacji aukcji jako podstawą wyboru potencjalnego klienta stanowi wartość dodaną poniższego badania. Unikalność badania jest reprezentowana przez punkt badawczy określony jako centrum pandemii. Pozostałe punkty badawcze określono na podstawie rozporządzeń polskiego rządu.

Słowa kluczowe: aukcja elektroniczna, platforma sprzedażowa, czynniki prezentacji aukcji, pandemia COVID-19, prezentacja aukcji na liście aukcji.

1. Introduction

The development of internet technologies brought changes to every aspect of mankind's economic activity. One of the most successful fields where internet technologies thrive is e-commerce. E-commerce influenced the market at its deepest nature, bringing new key factors and methods for developing successful strategies to reach potential customers.

A widely used definition of e-commerce states that e-commerce “refers to the use of electronic means and technologies to conduct commerce, including within-business, business-to-business, and business-to-consumer interactions” (Whinston, Choi, & Stahl, 1997, p. 13) within local areas or between residents of two or more countries (Chmielarz, 2001). However, internet technologies continuously develop, and along with them the concept of e-commerce. E-commerce is now perceived as trading over computer networks, such as the internet, through the usage of mobile commerce or electronic funds transfer (Shahriari et al., 2015), or specifically the internet as the medium for purchasing goods (Khan, 2016).

Among international markets, the Polish market is also affected by changes in global e-commerce. The value of the Polish e-commerce market is estimated at over USD 13.545 billion in 2021 compared to 11.900 billion in 2020 (Statista, 2021). The growth rate of 13% is predicted even taking

into account the negative impact of the global pandemic on the economy in 2020.

The enterprises involved in the competition for e-sales rise are online stores, sales platforms, and auction platforms. Auction platforms can also act as sales platforms. They sell goods of a physical and digital nature through an auction mechanism, which also involves a “buy now” option. Potential buyers encounter dynamically prepared websites where offers may come from multiple sellers, thus causing competition for the customer’s attention. The only way to get the attention of the buyer is through the attractive preparation of an offer. However, platforms reserve the factors to which buyers may be exposed. These factors differentiate offers among all others when the selection takes place.

The impacts of the global pandemic in 2020 were unprecedentedly wide. First, the declaration of a pandemic came from the WHO on March 11, 2020 (WHO, 2020). The responses from various governments differed. However, the first use of a travel ban could be perceived as a starting point of the pandemic. Different reactions would come later in the sequential reboots of closed economy branches. That did not come to e-commerce directly, but affected it indirectly through shortages of supplies or the fast adoption of tools for larger amounts of website traffic.

While the pandemic was underway, the analysis of auctions was mainly focused on the individual factors found in auctions. Attention has been paid to price analysis in connection with the type of auctions (Liu et al., 2019), negotiations (Jindal & Newberry, 2018), “premium” value (Snir, 2006), or their dispersion (Bounie et al., 2012). There has been also a review of marketing elements, which take into account offers based on their distinguishing elements (Stepnicka, 2013), or the analysis of phrases included in the title and content of the auction (Makowska, 2013).

The models focus on individual elements, while the sales platforms developed many elements that distinguish the auctions on the auction list. Research focused on one of the elements of auctions showed a noticeable deficiency in the analysis of omitting factors. The next issue came with the COVID-19 outbreak, where a lack of the inclusion of the pandemic in the research of auction offer lists created a research gap that needs to be addressed. Therefore, the aim of the current paper is to investigate how different stages of the pandemic affected the usage of auction presentation factors and their groupings.

The following research questions were specified:

Q1. Do different points in time of the pandemic differentiate the usage of the factors provided by the sales platform?

Q2. Do different points in time of the pandemic distinguish the composed groupings of factors (indexes)?

2. Research Methodology

2.1. Sales Platform and Auction Vignette

Sales platforms and auction platforms remain the aggregators of electronic sales. Sales platforms link different sellers as well as their own sales. Though there are many different sales platforms like Allegro, Empik.com, or Morele.net, Allegro is the largest one and is the most recognized among Polish internet users. In the PBI ranking of September 2020 (PBI, 2020), the Allegro platform took 6th place. Among auction platforms, Allegro has remained the major one in the e-commerce market in Poland. Competitors like Sprzedajemy.pl or OLX remain specifically oriented towards private individuals, or they do not provide a bid-auction mechanism. The world's largest sales and auction platform eBay, a competitor portal (for Polish users there is domain eBay.pl), offers sales opportunities for Polish online stores, but there is no in-country branch available in Poland.

Allegro is not only the largest e-commerce platform in Poland, but also one of the largest players in the world. In January 2020, it was among the top ten e-commerce sites in the monthly visits category, reaching almost 194 million visits (Ecommerce News, 2020). This places Allegro in competition with companies like Amazon or eBay and it is the only e-commerce platform from Europe to be included.

On sales platforms, auctions are organized into groups of interests. Groups are created based on product types. The platforms call them categories, and they are divided further until they reach indivisible, atomic subcategories. To issue an auction, a seller, among other things, needs to specify the atomic category. Then, the product is listed on the list of auctions containing vignettes of the product, i.e. a preselected set of auction factors. Based on examining the factors, a potential buyer could decide to proceed to the auction page or move on to the next product vignette. The vignette of a single offer usually includes several elements, such as name, photo, price, or product parameters. Since each auction could be issued with different factors, the same variant of product could be displayed many times with different sets of factors. Thus the competition takes place between offers. Finding the most optimized set of factors, especially in the case of long auction lists, may be the only way to attract the attention of a potential buyer.

2.2. Auction Factors in Studies

Studies related to the factors of the auction vignette are not consistent. Among the research, studies related to price dispersion analyses have gained in popularity. Price dispersion is intended to answer the question of whether the prices remain at the same level throughout the life of the auction. The

studies indicate that only a small group of sellers change the auction price (Bounie et al., 2012). The dispersion is also explained by factors such as a seller's recognition (Ba et al., 2012), where high price achievement is positively correlated with the seller's recognition. While this is significant, other factors like shipping costs are omitted. Another way of analyzing prices is to link them with reputation to achieve "premium" prices (Snir, 2006). Investigations of relationships between a sale and a price confirm the current market practices. However, the authors focused on studying the value of prices, while there were other factors on the sales platforms that change the perception of a price value, like discounts. This research gap means that the price should be perceived from a broader point of view.

Among the available factors, the ones which are connected with the marketing perspective are also depicted in a study made by Stępnicka (Stępnicka, 2013). This study concludes that some factors allow the visibility of offers to be increased. The research emphasizes the role of a standard list of offers which could lead to an increase in sales. The role of factors such as highlights, bolds, and features in the same context is emphasized. The study is a review of the possibilities, but does not include any quantitative analysis. Another aspect of these studies is the analysis of the values and evaluations of phrases contained in the descriptions of auctions, as well as in the listing of offers (Makowska, 2013). In her study, Makowska concentrated on the values found in auction phrases and listed them. However, the sample size was small and was aimed at the most popular auctions. The values conveyed in the description of an auction could be classified as advertising messages. The independence of the title as an element attracting the attention of a potential buyer was not emphasized directly, and it was the title of the auction that was the first visible element for the potential buyer. Studies of offer descriptions on the offers list should also fill this research gap.

Finally, the pandemic has an influence on the market. Studies related to this are new, but conclusions are also drawn on selected factors only. Hillen observed the influence of the pandemic on price indexes and the prices of selected goods, but there is a lack of observation of other factors which are also associated with goods being presented in an online list of products (Hillen, 2021).

The presented studies do not fill the research gaps. The provided study will contribute to the research by closing some gaps regarding auction vignettes on auction lists.

3. Hypotheses and Study Design

The study design included the identification of factors and indexes, formulating hypotheses, setting points in time, selecting category, gathering data, and data analysis.

3.1. Platform Factors and Indexes

The following dichotomous factors were identified on the sales platform:

1. Bold – bolding meant the option to write the offer title in bold.
2. Highlight – the offer itself was listed against a blue background.
3. Featured – the offer was shown above all other offers without this option.
4. Free shipping – the offer consisted of the seller’s assurance that the subject of the auction would be delivered to the buyer at no additional cost.
5. Shipping cost – the seller specified the shipping cost for the auction.
6. Participation in the “SMART” program – the Allegro “SMART” program allowed buyers who purchased access to this program to receive their goods at a pickup point at no additional shipping cost.
7. Participation in the “SMART with courier” program – the Allegro “SMART” program allowed buyers who purchased access to this program to receive their goods directly via a door-to-door system at no additional shipping cost.
8. “Bid” auction – the seller issued the auction in the form of a buyer-bid auction.
9. “Buy Now” auction – the seller issued the auction in the form of a buy-now auction.
10. “Allegro Coins” – the seller provided the currency “Allegro Coins” in the auction, which could be used in further purchases to lower the purchase cost.
11. “Installments Zero” – the seller shared the Allegro “Installments Zero” program, which indicated that the item could be bought through installments with no additional cost.
12. Discount – the seller specified information that the price of the item being sold was discounted.
13. Seller’s logotype – the seller bought the option to show its unique logotype in the vignette of the auction on the list of auctions.
14. “Super Seller” – information that the seller was participating in the Allegro “Super Seller” program. The “Super Seller” program is dedicated to the best sellers on Allegro if they meet certain requirements. These requirements, among others, consist of the fulfillment of orders, number of served customers, or listing new items within a specific period.
15. Company – an informational sign that the user appeared as a company.
16. Manufacturer authorization – information that the seller functioned under the manufacturer’s authorization.
17. Variants – information on the existence of product variants inside the offer.

In total, seventeen factors were qualified for use. Appropriate hypotheses were formulated for each of them:

H01: The pandemic will not affect the use of bolding.

H02: The pandemic will not affect the use of highlighting.

H03: The pandemic will not affect the use of featured.

H04: The pandemic will not affect the use of free shipping.

H05: The pandemic will not affect the use of shipping costs.

H06: The pandemic will not affect the use of participation in the “SMART” program.

H07: The pandemic will not affect the use of participation in the “SMART with courier” program.

H08: The pandemic will not affect the use of a “Bid” auction.

H09: The pandemic will not affect the use of a “Buy Now” auction.

H10: The pandemic will not affect the use of “Allegro Coins.”

H11: The pandemic will not affect the use of “Installments Zero.”

H12: The pandemic will not affect the use of a discount.

H13: The pandemic will not affect the use of the seller’s logotype.

H14: The pandemic will not affect the use of the “Super Seller” program.

H15: The pandemic will not affect the use of the company symbol.

H16: The pandemic will not affect the use of the manufacturer’s authorization.

H17: The pandemic will not affect the use of variants.

The following interval factors were identified on the item vignette on the auction list: product parameter numbers, title length, and number of words. For the specified factors, appropriate hypotheses were formulated:

H18: The pandemic will not affect the product parameters number.

H19: The pandemic will not affect the title length.

H20: The pandemic will not affect the number of words.

In the literature and on the platform information site, the factors are perceived with a more synthetic approach. The combination of factors also reflects the direction of the research undertaken in the literature, which focuses on groups of issues such as the description of the auction or transaction cost (Jeon et al., 2008), and such as product or price orientation (Ganesh et al., 2010). Chmielarz and Parys in their research (Chmielarz & Parys, 2017) pointed out that the prices of products are perceived similarly as prices with shipping costs. The combined factors could also provide a synthetic explanation in particular fields of study. On that basis, the factors were combined into indexes. The indexes were based on the literature, however there are also ambiguities in the assignment of the factors, e.g. price perception as a promotional element instead of price factor (Hillen, 2021). Hence, the indexes of the offer were prepared:

1. INDPromo – included options related to auction promotion: bold, highlight, feature. The indicator was created by summarizing the

- dichotomous variables. The classification of the promotional factors was made in accordance with the sales platform (Allegro, 2020b).
2. **INDShipping** – included options related to the shipping of goods: free shipping option, specification of shipping costs, participation in the “SMART” program, participation in the “SMART with courier” program. The indicator was created by summarizing the dichotomous variables. An indication for the classification of factors was based on a study of the importance factors for buyers by UOKiK (UOKiK, 2012).
 3. **INDPrice** – included options related to the price of the product: indication of a “Buy Now” auction, indication of a “Bid” auction, usage of the sales platform currency “Allegro Coins,” participation in the “Installments Zero” program, information about the price discount. The indicator was created by summarizing the dichotomous variables. The direction for the creation of the price indicator was provided by the UOKiK study (UOKiK, 2012), in which the respondents described the key role of price in making of a purchase decision.
 4. **INDSeller** – included the use of the seller’s logo, participation in the “Super Seller” program, company status, official or authorized shop. The indicator was created by summarizing the dichotomous variables. The direction was provided by Grabara’s study (Grabara, 2010) and from Allegro itself (Allegro, 2021). Allegro made a program available which distinguishes sellers based on their high-quality customer service, while Grabara stated that company sellers are differentiated from individuals.
 5. **INDProduct** – included product parameterization, i.e.: counting the product parameters specified in the offer and adding a value of 1 in the case of product variants. Product variants were treated as one of the product parameters. The indicator was created by summarizing the values of the variables. The indicator was created in connection with the concept of productization (Allegro, 2020a). Allegro introduced a productization program across its entire platform for the correct creation of offers. An important element of productization is the correct input of product parameters.

The creation of indexes was also followed by formulating the hypotheses:

H21: The pandemic will not affect **INDPromo**.

H22: The pandemic will not affect **INDShipping**.

H23: The pandemic will not affect **INDPrice**.

H24: The pandemic will not affect **INDSeller**.

H25: The pandemic will not affect **INDProduct**.

3.2. Sales Item Category

The rapid expansion of users with mobile internet access is considered a fundamental base for e-commerce. Mobile users are defined as persons using smartphones and tablets to connect to the internet. In September 2020,

22.4 million people were using the internet through personal computers at home and at work, and 24.4 million people were using mobile devices in Poland (PBI, 2020). The development of sales is additionally motivated by the development of mobile technologies (Einav et al., 2014). This is confirmed by the activities of both Polish (Morele.net, 2019) and foreign companies (New Media Age, 2011), which develop and optimize their mobile internet strategies. The trend is also seen on Allegro as a media owner. In January 2021, the real users of personal computers and laptops of the Grupa Allegro company numbered over 13 million, while for mobile devices the real users were over 18 million (PBI, 2021). From this point of view, the category featuring the well-known Samsung brand and their flagship S10 phone, introduced in 2019, was chosen. The choice of category was also motivated by the suggestion that online buying behavior tends to be goal-oriented (Wolfenbarger & Gilly, 2000).

3.3. Pandemic Points in Time

Pandemic points in time were taken at three points based on the beginning of the pandemic, when there was a surprise travel ban inside the country, the middle of the pandemic, where there was no indication of a change in the pandemic, and the time when the Polish government allowed a restart for all businesses closed during the pandemic.

The points in time were as follows:

1. March 15, 2020 – In this regard, the national quarantine started on March 15, 2020 (Prezes Rady Ministrów, 2020b). The amendment to the travel ban that followed could constitute a disorder related to the purchasing habits of individual customers. Moreover, the quarantine could be perceived by sellers as a situation that would affect their online offers provided on the online auction platform. The sample taken at that time made it possible to ignore the pandemic type of the phenomenon.
2. April 19, 2020 – a key pandemic point in time. This point was chosen at one month after the initial national quarantine with the introduction of a travel ban. The 30-day period was shifted to match the same day of the week (Sunday) as the first point in time of the current survey.
3. June 21, 2020 – on May 29, 2020, the Polish government publicized information that starting from June 6, 2020, the last of the closed businesses could reopen, i.e.: the hairdressing, beauty and fitness industries (Prezes Rady Ministrów, 2020a). In this regard, the restarting point was set at 2 weeks after the restart of all industries, that being June 21, 2020. The other indication for the containment of the pandemic was the announcement of the election of the President of the Republic of Poland on June 28, 2020, when all Polish citizens could freely move throughout the country (National Electoral Commission, 2020).

3.4. Sample Selection

The samples were recorded from the category page of S10 smartphones. The 1st point in time comprised 320 offers, the 2nd 259, and the 3rd 303. Only offers for Samsung phones and the sellers that the sales platform allowed to sell as business entities were considered. Gathering data proved to be different for the 3rd point in time. While in previous points there were no inconsistent category observations (i.e., there were no items other than Samsung items), at the last point items from different categories were observed. In the category of Samsung S10, devices of a different brand were recorded. Due to this occurrence, data cleaning was applied (Table 1).

Group	Analyzed observations	Initial observations	Removed observations	% of removed observations
1	320	320	0	0.0%
2	259	259	0	0.0%
3	303	599	296	49.4%
Total	882	1178	296	25.1%

Tab. 1. Initial and analyzed observations. Source: The author's research.

In total, for the 3rd point in time over 49% of observations were removed to retain the correct category perception of Samsung phones.

Registration took place once in a 24-hour period for each point in time.

3.5. Data Analysis

For data analysis, Microsoft Excel 2019 and R-CRAN version 4.0.3 software were used. R-CRAN software provides flexibility for cooperating with databases and includes packages that extend its capabilities. It also allows the design of research procedures by introducing them in the form of scripts.

Differences between the points in time were computed using the Kruskal-Wallis (K-W) tests for indexes and non-normally distributed data and chi-square independence tests (multiple proportions) for the dichotomous variables. Proportion and Dunn's all-pairs post-hoc tests were used for multiple comparisons. For the normality of the distribution, the Shapiro-Wilk test was applied. Following the remarks of Armstrong (Armstrong, 2014) to counteract the problems of group risk in multiple comparisons for unplanned hypotheses, the Benjamini-Hochberg procedure was performed (Benjamini & Hochberg, 1995). The p-value was set at 0.05.

The following abbreviations were used: p-value for probability of making type I error, SD for standard deviation, ME for median, IQR for interquartile range, SKE for skewness, df for degrees of freedom.

4. Results

Proportion tests were applied for the dichotomous factors. The results are provided in Table 2.

Hypothesis	Factor	Chi-squared statistics	df	Proportion timepoint			p-value
				1	2	3	
H1	Bold	0.706	2	0.056	0.054	0.069	0.702
H2	Highlight	0.706	2	0.056	0.054	0.069	0.702
H3	Featured	1.189	2	0.194	0.170	0.162	0.552
H4	Free shipping	0.873	2	0.375	0.413	0.393	0.646
H5	Shipping cost	10.85	2	0.803	0.838	0.898	0.004
H6	“SMART” program	4.738	2	0.381	0.405	0.465	0.094
H7	“SMART with courier” program	2.991	2	0.231	0.286	0.284	0.224
H8	“Bid” auction	11.451	2	0.200	0.162	0.102	0.003
H9	“Buy Now” auction	6.936	2	0.894	0.911	0.950	0.031
H10	“Allegro Coins”	6.351	2	0.109	0.131	0.178	0.042
H11	“Installments Zero”	0.908	2	0.181	0.158	0.155	0.635
H12	Discount	0.463	2	0.041	0.031	0.033	0.793
H13	Seller’s logotype	3.693	2	0.166	0.220	0.165	0.158
H14	“Super Seller”	5.862	2	0.259	0.197	0.185	0.053
H15	Company	11.357	2	0.778	0.799	0.878	0.003
H16	Manufacturer authorization	0.555	2	0.009	0.015	0.010	0.758
H17	Variants	0.252	2	0.222	0.224	0.238	0.882

Statistically significant tests were greyed out

Tab. 2. 3-sample test for equality of proportions without continuity correction for dichotomous factors. Source: The author’s research.

The results (Table 2) showed that the pandemic mostly did not change the style of factor usage. Hypotheses H01, H02, H03, H04, H06, H07, H11, H12, H13, H14, H16, and H17 were confirmed, while H05, H08, H09, H10, and H15 were rejected.

For significant test results, multiple comparison proportion tests were conducted (Table 3).

Factor	Compared timepoints	Proportion test statistic	df	Proportion		p-val	adj. p-val ¹⁾
				1	2		
Shipping cost	1–2	1.162	1	0.803	0.838	0.281	0.281
	1–3	10.863	1	0.803	0.898	0.001	0.003
	2–3	4.426	1	0.838	0.898	0.035	0.071
“Bid” auction	1–2	1.37	1	0.200	0.162	0.242	0.242
	1–3	11.493	1	0.200	0.102	0.001	0.002
	2–3	4.426	1	0.162	0.102	0.035	0.071
“Buy Now” auction	1–2	0.491	1	0.894	0.911	0.484	0.484
	1–3	6.916	1	0.894	0.950	0.009	0.017
	2–3	52.827	1	0.738	0.950	<0.001	<0.001
“Allegro Coins”	1–2	0.654	1	0.109	0.131	0.419	0.419
	1–3	6.024	1	0.109	0.178	0.014	0.042
	2–3	2.33	1	0.131	0.178	0.127	0.254
Company	1–2	0.381	1	0.778	0.799	0.537	0.537
	1–3	10.809	1	0.778	0.878	0.001	0.003
	2–3	6.482	1	0.799	0.878	0.011	0.022

¹⁾ p adjustment – Benjamini-Hochberg method *, Statistically significant tests were greyed out

Tab. 3. 2-sample test for equality of proportions without continuity correction for difference between 1st, 2nd, and 3rd pandemic timepoints in selected factors. Source: The author’s research.

Factor	Compared timepoints	Proportion test statistic	df	Proportion		p-val	adj. p-val ¹⁾
				1	2		
Shipping cost	1–2	1.162	1	0.803	0.838	0.281	0.281
	1–3	10.863	1	0.803	0.898	0.001	0.003*
	2–3	4.426	1	0.838	0.898	0.035	0.071
“Bid” auction	1–2	1.37	1	0.200	0.162	0.242	0.242
	1–3	11.493	1	0.200	0.102	0.001	0.002*
	2–3	4.426	1	0.162	0.102	0.035	0.071
“Buy Now” auction	1–2	0.491	1	0.894	0.911	0.484	0.484
	1–3	6.916	1	0.894	0.950	0.009	0.017*
	2–3	52.827	1	0.738	0.950	<5E-04	<5E-04*
“Allegro Coins”	1–2	0.654	1	0.109	0.131	0.419	0.419
	1–3	6.024	1	0.109	0.178	0.014	0.042
	2–3	2.33	1	0.131	0.178	0.127	0.254
Company	1–2	0.381	1	0.778	0.799	0.537	0.537
	1–3	10.809	1	0.778	0.878	0.001	0.003*
	2–3	6.482	1	0.799	0.878	0.011	0.022*

¹⁾ p-adjustment – Benjamini-Hochberg method, * test is considered as significant

Tab. 4. 2-sample test for equality of proportions without continuity correction for difference between 1st, 2nd, and 3rd pandemic timepoints for significant test results of dichotomous factors. Source: The author’s research.

In each of the tested factors, at least one test was found to be significant, thus supporting all significant results obtained from the proportion tests (Table 2).

The descriptive statistics of title length, number of words, and product parameters are provided (Table 5).

Factor	Mean	SD	ME	IQR	SKE
Title length	45.175	5,312	47	6	-2.110
	45.336	5.241	47	6	-2.262
	44.789	5.270	47	8	-1.877
Number of words	6.222	1.329	6	1	-0.833
	6.189	1.323	6	2	-0.739
	6.063	1.242	6	2	-0.366
Product parameters	4.000	0.000	4	0	-
	4.000	0.000	4	0	-
	4.000	0.000	4	0	-

Tab. 5. Descriptive statistics of title length, number of words, and product parameters factors. Source: The author's research.

The numbers of characters at all pandemic points in time were characterized by the same median ($Me = 47$) as well as the left skewed distribution. The same type of distribution was found in the number of words factor with a median value of 6 ($Me = 6$). The product parameters factor was not analyzed further after obtaining the same scalar value (4) for each point of time of the pandemic.

For the analysis of the title length and number of words, the Kruskal-Wallis test was applied due to the non-normal distribution of the data (Table 6).

Factor	W statistics	p-value
Title length	0.811	< 2.2E-16*
Number of words	0.923	< 2.2E-16*

* test is considered as significant

Tab. 6. Shapiro-Wilk's test results of title length and number of words factors. Source: The author's research.

The results of K-W tests for the title length and number of words are provided in Table 7.

Factor	Kruskal-Wallis chi-squared statistics	df	p-value
Title length	2.480	2	0.289
Number of words	5.450	2	0.066

Tab. 7. *Kruskal-Wallis rank sum test results of title length and number of words factors. Source: The author's research.*

Although the number of words should be carefully examined due the p-values being not as high ($p = 0.066$) as the title length ($p = 0.289$), both results supported hypotheses H19 and H20 that the pandemic did not change the way the titles were constructed.

Analysis of indexes

The descriptive statistics for indexes are provided in Table 8.

Index	Mean	SD	Me	IQR	SKE
INDPromo	0.306	0.743	0	0	2.739
	0.278	0.726	0	0	2.916
	0.300	0.792	0	0	2.758
INDShipping	1.803	1.248	2	2	0.075
	1.950	1.243	2	2	-0.050
	2.043	1.180	2	2	-0.095
INDPrice	1.425	0.598	1	1	1.165
	1.394	0.535	1	1	0.882
	1.419	0.640	1	1	1.246
INDSeller	1.213	0.905	1	1	0.405
	1.232	0.902	1	1	0.477
	1.238	0.787	1	1	0.818
INDProduct	4.222	0.416	4	0	1.332
	4.224	0.418	4	0	1.317
	4.238	0.426	4	0	1.227

Tab. 8. *Descriptive statistics of indexes. Source: The author's research.*

The median and interquartile range (IQR) values showed that the pandemic did not change the location of indexes. However, the indexes were tested with the Kruskal-Wallis test to support this assumption (Table 9).

Factor	Kruskal-Wallis chi-squared statistics	df	p-value
INDPromo	0.931	2	0.628
INDShipping	5.984	2	0.050
INDPrice	0.315	2	0.854
INDSeller	0.222	2	0.895
INDProduct	0.252	2	0.882

Tab. 9. *Kruskal-Wallis rank sum test results of indexes. Source: The author's research.*

The tests of the indexes were also in favor of hypotheses H21, H22, H23, H24, and H25. However, the p-value for INDShipping was inconclusive ($p = 0.05$). In this case, the post-hoc tests for different points in time are provided (Table 10).

Comparison timepoint	Dunn's statistic	p-value	Adj. p-value ¹⁾
1-2	1.416	0.157	0.235
1-3	2.425	0.015	0.046*
2-3	0.898	0.369	0.369

¹⁾ p-adjustment – Benjamini-Hochberg method, * test is considered as significant

Tab. 10. *Dunn's all-pairs test for INDShipping. Source: The author's research.*

Dunn's test results for INDShipping showed that the index could not be easily accepted in support of hypothesis H22.

5. Discussion

The aim of this study was to investigate how different stages of the pandemic affected the usage of auction presentation factors and their groupings.

The results supported the hypotheses claiming that the pandemic did not affect their usage. Factors regarding the usage of bold, highlight, and feature and their synthetic indicator INDPromo did not differ during the pre-, deep, and post-pandemic points in time. What is more, the values for both bold and highlight factors remained the same. This is not an error and is supported by the sales platform strategy which allows sellers to buy promo factors for significant discounts if the factors are bought together. There is a change in their proportions at the 1st point of the pandemic at a level of 0.06, the level at the 2nd point decreases to 0.05, and the level rises to 0.07 at the 3rd point; however, the proportion tests do not confirm

statistical significance ($p = 0.55$). The synthetic INDPromo did not reveal substantial changes between the points in time ($K-W = 0.93$, $p = 0.63$); even the value of the index at the 2nd point decreases to 0.28 in opposition to 0.31 at the 1st and 0.30 at 3rd points. However, the feature factor showed a persistent decrease in value from the 1st point to the 3rd point (0.19 to 0.16). If the situation persisted, it could cause the loss of revenue for the sales platform and the use of cost optimization strategy by sellers. The feature factor is highly recommended by the sales platform and is more expensive for the buyer than the highlight and bold options.

One of the elements which did not support the hypothesis of the pandemic influence was shipping cost. A significant proportion of usage change was registered between the 1st and 3rd points ($p < 0.01$), implying the slow growth of the visibility of shipping cost on the offer presentation vignette. This is particularly interesting in comparison to shipping factors unchanged by the pandemic, like the free shipping factor, "SMART" program, and "SMART with courier" program. One of possible explanations is that providing the shipping cost for buyers clearly reduces the uncertainty of the offer's shipping cost. The overall uncertainty of the pandemic could be discounted by reducing the unknown, i.e. by providing more information to the buyer. The associated index in this case, INDShipping, should also be carefully examined, while the K-W test showed inconclusive results ($p = 0.05$), whereas Dunn's all pairs tests showed a significant change between the 1st and 3rd points, implying the constant growth of the index.

In the case of product variety, the situation was the same for all offers. All the parameters available for the products were properly filled. The case of variants of product availability for a given offer was unaffected by the pandemic. To conclude, the associated index INDProduct finally supports hypotheses H17, H18, and H25. The explanation for this could be provided by the Allegro "productization" program (Allegro, 2020a).

The following price factors partially support the hypotheses of the pandemic not affecting them: "Installment Zero" (H11), Discount (H12), and indicator INDPrice (H23). In direct opposition to them, hypotheses H08, H09, and H010 were not supported, representing the usage of the "Bid" auction, "Buy Now" Auction, and "Allegro Coins" factors. Differences were found between the proportion of their usage. For the "Bid" auction, the comparison between the 1st and 3rd points was significant (1–3), implying that the change did not occur instantly, but continuously. The registered proportion decreased from 0.20 to 0.10. Periods 1–2 and 2–3 did not reveal significant changes. The same type of changes arose for the "Allegro Coins" factor. The usage of the factor increased from 0.11 to 0.18, however the influence of the pandemic was continuously seen. There were differences between the 1st and 3rd points in time, while none were registered for periods 1–2 and 2–3. The changes for the "Buy Now" auction were only

seen from the 2nd point, i.e.: periods 2–3 and 1–3. The growth of the usage of factor proportion was found to first be 0.89, then 0.91, and ending at 0.95. This kind of behavior implies that the changes began at the deep pandemic level and proceeded further. The evolution of the usage of the “Buy Now” option factor has a more rapid character and could end with almost all goods being sold with the “Buy Now” option.

Hypothesis H12 regarding the discount factor was supported by the proportion test. While there was no statistical significance between the proportions, the proportions declined from 0.04 at the 1st point to 0.03 at the 2nd and 3rd points, implying the loss of seller interest in this factor. These findings stand in opposition to other studies of online buying behavior during the pandemic, where discounts are the main motivating factor for online shopping (Gabriel & Loredana, 2020).

The current study revealed that INDPrice resisted the influence of the pandemic and remained at the same level for all three observed points of the pandemic. The price concept is perceived as a motivator for online buying (Jeon et al., 2008) and should have already reached a mature stage of development. During the pandemic, the change of the price index is not perceived as a significant increase for online shops. While some prices increased and some did not, the overall index did not change (Hillen, 2021). This is no different in the current study. The creation of the index for offer price elements reflects changes in the price indexes of other studies.

A majority of seller information factors offered through a presentation vignette supported the following hypotheses: seller logotype (H13), “Super Seller” program (H14), manufacturer authorization (H16) factors, and index INDSeller (H24). In the study of price dispersions (Ba et al., 2012), seller recognition is stated as one of the factors affecting high price achievement. While taking a closer look at the seller’s logotype factor, even if there is no statistical significance between the points in time, in the deep pandemic stage there was an increase in its usage. At the 2nd point, the usage grew to 0.22 compared to 0.17 at the 1st and 3rd points, which could support the importance of the seller’s logotype as an effective tool for auction promotion especially in the case of market phenomena. Nevertheless, the company factor did not support its hypothesis (H15, $p < 0.01$), and further examination of multiple comparison proportion test results revealed that starting from the 2nd point (i.e. 1–3 and 2–3), the company factor usage increased from 0.78 (1st point), to 0.80 (2nd point) and 0.88 at the 3rd point. The increase in this factor can be explained by the existence of different types of Allegro sellers. Not all sellers need to be registered with a company account to act as a company. However, as the results show, the explanation for the rise in company importance could be the pandemic forcing sellers to use the proper type of formal account.

The final examined factors were associated with the title. However, the factors for title length as well as number of words did not show any changes

encouraged due to the pandemic. Title length, with the same median of 47 characters throughout all points of the pandemic, acted in the same manner as the number of words with a median of 6 words. A slight change was seen in the 3rd point in time for IQR, increasing from 6 characters to 8 for title length and from 1 to 2 words in the number of words, however it was not enough to reject hypotheses H19 and H20.

In conclusion, there is no significant influence of the pandemic on synthetic indexes (research question Q2), while the answer to Q1 is inconclusive. There are hypotheses which support the lack of pandemic influence: H01, H02, H03, H04, H06, H07, H11, H12, H13, H14, H16, H17, H18, H19 and H20; but there are also hypotheses which should be rejected, indicating that the pandemic was the source of changes: H05, H08, H09, H10, H15.

6. Limitations of the Study

The large number of sellers on Allegro, with over 100,000 registered companies and millions of goods offered each day, limited the possibility of drawing correct samples. In this perspective, the sampling technique was limited to the preselected category of smartphones. For the present study, one of the well-known brands on the Polish market was chosen. At the time of the survey, the Samsung flagship S10 phone was already superseded by the new generation of the S20. However, the S10 has been well-established on the market and did not suffer from a scarcity of supplies, which could be problematic in the case of the newest S20. In this case, it should also be addressed in future research involving a comparison of usage factors between different types of categories.

The second limitation of the study was the sample bias introduced by the non-category brand in the 3rd point in time. Incorrect data was observed and the sample was cleaned, however problems like this could be difficult to discover if the samples were too large for thorough inspection.

Another limitation involves finding correct points in time for the study. While government regulations are the most basic and formal options, in the case of the deep stage of the pandemic the choice is not as clear. In this case, the point is arbitrarily chosen with a few ideas in mind, like the basic period of offer presentation proposed by the platform and the same weekday as the first survey.

A final limitation includes ambiguities for the assignment of the factors which arise from the literature.

7. Conclusion

The influence of the pandemic is perceived as a source of growth for the e-commerce industry. However, the growth is not only applicable to

revenue. The pandemic affects e-commerce in many ways, one of them being the change in the presentation factors of offers.

The study results found interesting behavior for the “Buy Now” option factor, which could lead to great changes in the perception of auction platforms. The rapid growth from the deep-pandemic state implies that instead of being auction platforms, there is a developing perception of these sites as sales platforms. This kind of change is also supported by the platform itself scaling its development only for commercial sales and moving private sales to the separate local auction platform. Other findings are that some of the promo options always occur together, regardless of the pandemic and offer changes. This final point is noteworthy and should be further examined for different categories.

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The Impact of the Pandemic (COVID-19) on Globalization – The Perspective of Electronic Commerce

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Abstract

Purpose: The objective of this article is to examine the impact of e-commerce and m-commerce on broadly perceived globalization factors before and during the COVID-19 pandemic in the opinion of customers.

Design/methodology/approach: The CAWI method was used with the participation of individual, active internet users from both periods. The differences between the results were analyzed using the distance indices: city distance and Euclidean distance. The data from March 2020 (before the pandemic) and from December 2020 (during the pandemic) were used as the basis for comparisons.

Findings: The findings point to increasing diversification in the product/services range and the growing number of goods and services purchased abroad. There occur much smaller differences with regard to infrastructure factors which have a direct influence on foreign e-commerce. Also, in the respondents' opinions, greater popularity and more frequent use of international commerce solutions during the pandemic is treated as a factor which supports the development of globalization. The main observed changes during the COVID-19 pandemic are infrastructure changes (staying at home, remote learning, remote work, etc.) and an extend and standardized approach to e-commerce. The second equally important effect is the shift from desktop computers to mobile devices.

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Research limitations/implications: The limitation resulted from the research sample obtained in the academic environment. Students are a group supporting the globalization processes, where e-business solutions are widely used, but their purchases of products/services, including foreign goods, are often limited due to lack of funds.

Originality/value: The original value of the article is the identification and specification of the main factors supporting globalization in Poland during the COVID-19 pandemic from the point of view of electronic commerce.

Keywords: e-commerce, globalization process, e-commerce impact on globalization, pandemic impact on globalization, COVID-19.

JEL: M15, L81, L86, O33

Wpływ pandemii (COVID-19) na globalizację z perspektywy handlu elektronicznego

Streszczenie

Cel: zbadanie wpływu e-commerce i m-commerce na szeroko rozumiane czynniki globalizacji przed i w trakcie pandemii COVID-19 w opinii klientów.

Metodologia: zastosowano metodę CAWI z udziałem indywidualnych, aktywnych internautów z obu okresów (sprzed i w trakcie pandemii). Różnice między wynikami analizowano za pomocą wskaźników odległości: odległości miejskiej i odległości euklidesowej. Za podstawę porównań posłużyły dane z marca 2020 r. (przed pandemią) oraz z grudnia 2020 r. (w czasie pandemii).

Wyniki: wskazują na coraz większą dywersyfikację asortymentu produktów/usług oraz rosnącą liczbę towarów i usług kupowanych za granicą. Dużo mniejsze różnice występują w zakresie czynników infrastrukturalnych, które mają bezpośredni wpływ na handel zagraniczny. Również w opinii respondentów większa popularność i częstsze korzystanie z międzynarodowych rozwiązań handlowych podczas pandemii jest traktowane jako czynnik wspierający rozwój globalizacji. Główne zmiany zaobserwowane podczas pandemii Covid-19 dotyczą zmian infrastruktury (pozostawanie w domu, nauka zdalna, praca zdalna itp.) oraz rozszerzenie i standaryzacja podejścia do e-commerce. Drugim równie ważnym efektem jest przejście z komputerów stacjonarnych na urządzenia mobilne.

Ograniczenia/implikacje badawcze: ograniczenie wynikało z próby badawczej uzyskanej w środowisku akademickim. Studenci to grupa wspierająca procesy globalizacyjne, gdzie rozwiązania e-biznesowe są szeroko stosowane, ale ich zakupy produktów/usług, w tym towarów zagranicznych, są często ograniczone z powodu braku środków.

Oryginalność/wartość: oryginalną wartością artykułu jest identyfikacja i specyfikacja głównych czynników wspierających globalizację w Polsce w czasie pandemii COVID-19 z punktu widzenia handlu elektronicznego.

Słowa kluczowe: e-handel, proces globalizacji, wpływ e-handlu na globalizację, wpływ pandemii na globalizację, COVID-19.

1. Introduction

The main purpose of the study is to specify the differences between customers' opinions concerning the impact of e-commerce on globalization processes before and during the COVID-19 pandemic. In Poland, the manifestations of the response to the coronavirus pandemic began to be noticed in mid-March 2020. With minor changes in terms of scope, they have

mainly consisted in: no possibility of conducting business, cultural or didactic activities for a specified period, the obligation to wear protective masks as well as restricted travel and commuting in the country and abroad. The latter sometimes appeared to be sudden, unreasonably strict and incomprehensible. On the one hand, these restrictions were supposed to limit the dynamics of the spread of the new virus, and on the other, they could be interpreted as an expression of the powerlessness of the authorities faced with the failure to combat the disease in its initial phases. The other reason might be the intention to observe the same rules and impose similar restrictions which other countries had introduced, without any deeper analysis or consideration for the situation in our country. The economic and social constraints caused by the coronavirus led to the economic crisis. Undoubtedly, its depth would have been even greater had it not been for the possibility of introducing remote work and the use of internet and mobile e-commerce tools. The abovesaid tools support the sale of products and services in line with the rules of social distancing, enabling contactless transactions between sellers and buyers. The ongoing process of homogenization of information technologies and commonly used software applications leads to establishing similar and somewhat standardized purchasing and social behavior related to e-commerce. The latter is translated into the convergence of societies on a global scale: it supports and facilitates globalization processes. It is important to note that the definitions of globalization are indeed changing to emphasize social factors occurring in the above processes; however, it seems that information technology supporting e-commerce still plays a dominant role in this area (Makarova, Makarova, & Korsakova, 2019). The latter is especially noticeable in a period of crisis that prevents or restricts purchases carried out using other methods. The research questions, therefore, focus on determining the impact of information technology, especially e-commerce, on globalization before and during the pandemic since the present situation that forces people to stay at home should support and contribute to e-commerce development. The objective of this study is to examine whether it is so, and what changes took place during the first nine months of the crisis. In the light of the analyzed literature, there emerges a research gap, which some considerations contained in the paper hope to fill, at least to a certain degree.

The article consists of five parts. After the introduction, the authors have carried out a review of the literature discussing the topic presented in this paper. The next section specifies the research method and describes the research sample. The fourth part presents the findings of the study and discusses them. The last section contains conclusions from the conducted research procedure, limitations of the research and directions for its further development.

2. Literature Review

Since the announcement of the COVID-19 pandemic, apart from analyses related to medical research and potential solutions and remedies, researchers have also begun examining the impact of the pandemic on economic and social life. OECD highlights the influence of e-commerce in terms of overcoming some of the consequences of the pandemic (Lopez-Gonzalez et al., 2020). The World Economic Forum (Fan & Gallaher, n.d.) also appreciates the significant role of e-commerce in mitigating the present crisis. However, there are still numerous limitations to e-commerce, which are particularly visible during the pandemic (NielsenIQ, 2020). This is the reason why e-commerce is not developing as fast as it may seem viable under the conditions of the COVID-19 threat. There are also significant regional differences which result from cultural and technological conditionings. For example, the development of e-commerce in South Korea differs considerably from the circumstances in the USA (Cho et al., 2020). Although South Korea is regarded as one of the most technologically advanced countries in the world, the USA has the advantage resulting from the years of “testing” of mobile and website-based purchases during periods of intensive internet use. The awareness of both potential and tangible benefits resulting from e-commerce is also one of the factors differentiating consumer behavior in these two countries.

One of the most significant problems considered during the pandemic is the state and dynamics of the development of the agri-food sector (Hillen, 2021). This applies in particular to small and medium-sized enterprises (SMEs) in this area (Anacleto et al., 2020), sometimes also very small businesses. Some sectors, like the flower industry, are on the verge of collapsing while others, like the food industry, experience the inconvenience of the crisis only in the area of deliveries to restaurants and hotels (Dannenberg et al., 2020), (Hao, Wang, & Zhou, 2020; Thilmany et al., 2021, p. 19). The issue of minimizing the risks related to economic activity is another subject area analyzed under the present circumstances of the pandemic. From companies' perspective, it is connected, on the one hand, with effective marketing applications (Wang et al., 2020), and on the other, with organizational and technological improvements supporting online sales processes (He, Zhang, & Li, 2021; Pantano et al., 2020, p. 19). Less frequently, this risk is analyzed from the point of view of international e-commerce or globalization (Sharma et al., 2020).

Occasionally, there appear articles and other publications concerning the impact of the global pandemic on the environmental economy. The papers present its positive influence such as reducing environmental pollution as well as the negative impact, namely, increasing the amount of waste caused by the disposal of products that help combat COVID-19 (Schumacher, 2020).

The issue of using e-commerce during the pandemic is also considered from the point of view of the consumer (buyer, customer) as well as a manager of e-business. The first one relies on the availability and quality of websites and mobile applications, while the second one focuses on designing them in such a way as to best reflect users' requirements (Paștiu et al., 2020).

In this context, other significant research areas include the impact of the pandemic on the users' behavior under the circumstances of remote work/telecommuting, its potential development and future implications, also after the pandemic (Carroll & Conboy, 2020), the related experiences in this area and their consequences and benefits for their lives (Brem, Viardot, & Nylund, 2021).

However, the issue related to e-commerce development supporting the processes of globalization during a pandemic (COVID-19) from the point of view of an individual customer is rarely considered as a separate research topic. As a result, the conducted analyses are usually fragmentary. This article focuses on filling the relevant research gap, at least to a certain degree.

3. Methodology

The primary method used in the study was the CAWI (Computer Associated Web Interview) interview and the survey questionnaire, which was carried out in March 2020 and in December 2020. The research procedure included the following stages:

- selecting the research sample, justifying the selection procedure and carrying out a pilot study,
- constructing a prototype of a survey examining the influence of e-commerce on globalization processes during the pandemic and its verification with the participation of a pilot sample,
- carrying out the study using a verified and tested survey questionnaire, placed on the servers of the University of Warsaw,
- conducting two surveys involving a similar study sample – the first survey questionnaire was circulated before the pandemic, and the second one during the pandemic,
- analysis and discussion of the obtained findings and drawing conclusions from the study.

The study sample included the students of the University of Warsaw. It was selected in a convenient and purposeful manner. It was a case of convenient sampling because contacting the respondents by posting an invitation on the website of the Faculty of Management was relatively easy, and the manner in which the studies were completed seemed useful to be applied as part of future assignments related to seminar projects and diploma topics. This was a purposeful study since this age group included the individuals who most frequently used the internet to do shopping. Moreover,

this group consists of internet users who, due to the present conditions of the pandemic, participate in online lectures and classes. Some of the students also use the internet to work remotely (70% of the students of the Faculty of Management at the University of Warsaw have jobs), and thus they are well familiar with the working conditions which rely on the application of common ICT (Information and Communication Technologies) tools which support globalization processes. Thus, it appears that their opinions on the changes related to the impact of information technologies on globalization processes can be treated nearly as based on professional competence. Thus, it emerges that the survey was completed by the part of the population who tend to use the internet, hardware and software most frequently. They practice and master relevant IT skills using computers, laptops, smartphones and tablets.

In the first examined period in March 2020, the online survey in its full form was filled in correctly by 240 individuals, which constituted a 69% share of the population who had received invitations to complete the questionnaire, in the second case in December 2020, the research sample included 111 individuals (32%).

Among the respondents, there were only minor differences with regard to gender between the surveys conducted in both periods. In March 2020, the share of women amounted to 63%, and there were 37% of male respondents; in December 2020, there were 61% of women and 39% of men. A similar tendency was observed in terms of the age differences: namely, in December 2020, the sample consisted of 98% of individuals from the 18–24 age group, and six months earlier, the share amounted to nearly 97%. The average age of the survey participants was estimated at slightly over 22 years. This is a standard age of BA students and those of first years of MA studies. Thus, in the category of education, the indications related to secondary education (high school, technical school) and post-secondary education were dominant in the group. In the case of both analyzed periods, the respondents mainly came from households consisting of 3–4 persons (28% on average).

The greatest differentiation was recorded in terms of the place of residence. On average, over 56% of the respondents declared that they came from cities with more than 400 thousand residents, over 15% from cities with 100,000–400,000 inhabitants and more than 17% came from rural areas. The share which decreased the most – by nearly 10% in relation to the previous study – included individuals coming from cities with over 400 thousand residents. A slightly lower differentiation – nearly 8% – could be observed in the case of inhabitants of cities with 100–400 thousand residents.

As regards the assessment of students' financial situation, still the largest share of students (54% on average) evaluated their situation or the situation of their family as good, which means that they claimed that they could afford many things without any particular need to save money. In turn, the largest differences (around 4%) occurred at two ends of the ranking. The average number of respondents who perceived their financial situation as

very good decreased, and simultaneously, the share of survey participants who saw their situation as very bad increased.

The differences which occurred between the two research samples were relatively small due to the fact that the survey was conducted in a similar group of respondents, characterized by a similar structure in terms of gender, age, education and social status. This allowed for high comparability of the results in both examined periods, at the beginning of the COVID-19 pandemic and during the pandemic, during which, at the moment of conducting the study, Poland experienced the largest number of occurrence cases in 2020.

4. Analysis and Discussion of the Findings

The verified online survey consisted of twenty-five substantive questions as well as demographic data describing the study sample.

The first question was aimed at identifying the research area. The respondents were presented with five examples of definitions of globalization related to integration, economic and social, cultural dispersion, unification and one related to technological changes (Little, 2016; PIIIE, 2018; Chakravartty & Sarikakis, 2006; Makarova et al., 2019; Wani, 2011). The survey participants were asked which of the provided definitions, in their view, best reflects the essence of this phenomenon. Nearly 41% of the respondents found the definition associated with integration to be the one which best describes the phenomenon. This definition presented globalization as *...the entirety of processes leading to increasing interdependence and integration of states, aimed at creating a global society, accelerated by the proper use of information technologies...* (PIIIE, 2018). The highest score of this definition increased in the last ten months in 2020 by around 10%. However, the recognition of the [integrational?] unification-related definition stating that globalization can be described as *...the increase in interdependence, interaction and unification in the economic and social sphere globally, which intensifies together with the fast technological progress...* (Chakravartty & Sarikakis, 2006) decreased by a similar value. In the case of all analyzed definitions, the achievement of an appropriate level of technological development, mainly, common access to the internet as well as e-commerce, e-banking and generally perceived social media services is the necessary factor determining globalization processes and contributing to their further development. The subsequent survey questions focused mainly on the economic aspects of globalization processes and the impact of the COVID-19 pandemic on these processes.

Further questions concerned the respondents' assessment of the impact of information technologies on globalization. On average, 54% of the respondents selected the responses pointing to the strong influence related to this factor. On the other hand, the most significant increase (11%) was recorded in the case of the category of decisive influence (currently 51% of

the respondents), mainly at the expense (10%) of the opinion concerning a strong influence (currently 47%). The share of the remaining categories (average or limited influence) does not exceed 3%. The assessment of the most frequent manifestations of this influence appears to be the expansion and deepening of the analysis pertaining to the previous question. 22% of the respondents pointed out that the most important factors, in this case, were diversified access to the flow of goods and services through electronic commerce (both website-based and mobile solutions) and enabling access to world markets offering different prices as well as a diversified product and services range (18%). COVID-19 led to a 4% increase related to both opinions. A greater choice in terms of financial services and payments (both electronic and mobile payments) was the factor which tended to be most appreciated in this period (an increase of 6%). Interestingly, the respondents attach much less importance to the technical aspects of software and hardware standardization related to the globalization of economic activity or the standardization of electronic platforms and channels (a decrease of 2–4%). They also attach little importance to the popularization of languages on a global scale or unified knowledge standards (11%). It is worth mentioning at this point that more and more websites or mobile applications are translated into most popular languages, such as the English language, which facilitates the globalization processes. It also means that this aspect is no longer considered a significant problem in e-commerce.

The survey participants pointed out that more accessible individual cross-border e-commerce and e-banking services (24%, an increase of 5% by December 2020) were the main advantages of information technology as a stimulus of globalization processes.

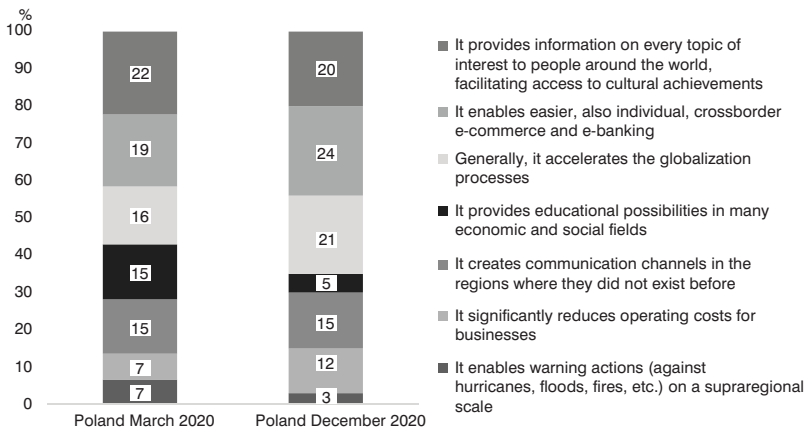


Fig. 1. The comparison of advantages of information technologies as stimuli of globalisation processes in Poland during the pandemic (March and December 2020). Source: Own work.

The second place was taken by the general acceleration of globalization processes (21%, a 5% increase by December 2020), and the third position was taken by providing information on every topic of interest to people around the world, facilitating access to cultural achievements (20%). After nearly a year, remote education is not greatly appreciated (5%, a decrease of almost 10% in relation to previous findings). The results of the comparison are shown in Figure 1.

The distribution of opinions concerning the main obstacles to globalization processes posed by information technology during the pandemic was as follows: the sole dependence of economic activity on technological development (20%), the dissemination of cultural patterns, originating mainly from the most technologically developed societies (19%) and the perception of development only by the primacy of technology (15%). In all these categories, the share of opinions increased by around 5%, at the expense of the previous average variation at the level of 14%. The share of opinions on underdeveloped countries used as a technological landfill, i.e. the market for used old information technologies, decreased the most and was estimated at 5% (the difference amounts to 10%). This view does not seem to be as true as before. The results are presented in Figure 2.

Similarly to the case of information technologies, the respondents were also asked about the strength of the influence of e-commerce on globalization phenomena. And thus, when assessing the strength of the impact of e-commerce on globalization processes in December, 96% of respondents evaluated this impact as decisive or strong, which is 10% more than at the beginning of the examined period. The number of opinions associated with an average impact on globalization also decreased, and no one assessed it as none or weak. This is undoubtedly the result of constant difficulties in doing shopping in a traditional way, closing shopping malls, etc. The greatest impact on the phenomenon of globalization during the pandemic is manifested by the increased availability of goods and services unavailable in the country, marked by 25% of respondents (2% more than previously), and greater choice of domestic and foreign products and services available at the most attractive prices – an average of 24% of responses (an increase of almost 7% in relation to the previous period). The third place was taken by the possibility of comparing prices and characteristics of goods and services in Poland and abroad – 14%. The respondents attach much less importance (over 9%) to the possibility of buying and selling to countries using the internet network. It already seems so obvious, especially during the pandemic, that the respondents do not consider this to be a particular manifestation of the impact of electronic commerce on globalization.

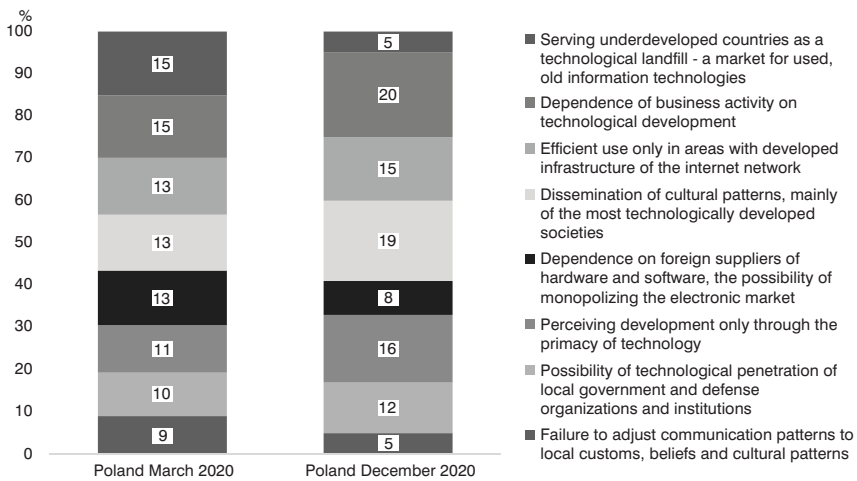


Fig. 2. The comparison of the specific disadvantages of information technologies as barriers to globalisation processes in Poland during the pandemic in Poland (March 2020 and December 2020). Source: Own work.

In the analyzed period, there were changes in the approach to the existence of restrictions imposed on international e-commerce as a factor of increasing globalization. As in previous articles, the authors have listed six possible barriers to international e-commerce connected with economic, organizational, legal, technological, cultural and security-related aspects. During the pandemic, the attention of respondents moved from security-related barriers (22% in the present study) to purely economic barriers (25%, which represents an over 8% increase). The approach to legal barriers remained almost unchanged, with a slight decrease in terms of awareness of these barriers. However, the issue of their importance is slightly different. Here, the order is changing: security barriers are still considered the most important (45%), followed by economic and legal aspects; however, the fourth position is occupied by psychological restrictions, exceeding 10%. Perhaps the reason for such a tendency is related to the fatigue of the continued constraints enforced by the pandemic.

Thus, a question arises: what do the respondents see as the most significant barrier in terms of purchasing products/services of foreign origin using e-commerce solutions? The first places appear to reflect the standard limitations related to:

- the high price of a product/service combined in the case of a product with a high price of delivery, especially from a foreign country (an increase during the nine months of the pandemic of almost 5%, estimated at 20%),

- no sense of security in the case of using foreign websites and doubts regarding filing complaints (an increase of 3%, amounting to 18%),
- local regulations imposing customs duties or other preference for domestic products/services (an increase of nearly 3%, reaching the level of 17% until March 2020),
- no sense of security resulting from the use of software and hardware – a greater possibility of transferring viruses from abroad (an increase of 3%, amounting to 12%),
- worse price/quality relations in the case of products/services of foreign origin in relation to domestic goods (an increase of nearly 3%, to 11%),

The general tendency that occurs in this comparison is an increase of about 3% of the indications related to the factors which were seen as the most essential factors even before the pandemic; however, infrastructural, cultural or psychological factors do not appear to be important.

However, the responses concerning the frequency of purchases tend to be closer to the values associated with higher frequency average. In December 2020, 35% of the respondents gave the answers indicating very often and often, which is 10% more than in March 2020. A similar increase was observed in the case of the sometimes category, and the increase occurred at the expense of the 21% decrease related to rarely responses.

The information concerning foreign products and services available on the internet is consistently obtained mainly from forums and social media platforms (31%, which constitutes a decrease of 4% in comparison with the situation recorded before the pandemic), from online shop websites (28% of responses, an increase of 5%) as well as the manufacturer's websites (25%, which constitutes an increase of 4%). There was also a 5% decrease in internet advertising as a source of information about goods and services. At the same time, the information published in newspapers and magazines, including specialist and trade magazines, or radio and television commercials and programs became almost entirely irrelevant. Information shared by friends and family is scarce, and this share further decreased by 3% during the pandemic (currently 5% of opinions).

When they already have information about foreign goods/services, 41% of respondents (3% more than at the beginning of last year) use comparison websites. These solutions are used to find the most attractive price as well as the website or location where the product/service can be purchased. A 6% smaller share of respondents find information about a product/service online, and they also try to purchase it online (3% increase). On the other hand, fewer people (22%, 3% less) postpone their purchasing decision until they visit a traditional, brick and mortar store where they check the quality of the goods/service and decide whether the product/service would meet their needs. In total, also a 3% smaller share visit specialist shops and showrooms. During the pandemic, it emerges that the mobility inducing

the respondents to search for products/services both on the internet and in physical locations has decreased.

One can also assume that during the pandemic, the awareness among customers with regard to the origin of foreign goods/services according to brands (21%) and the Made in... label (47%) has increased (an increase on average by 2%).

Among all the factors which determine the online purchase of foreign goods/services rather than domestic ones, two of the characteristics came to the fore. These were: the reputation or prestige of the brand (11%) and the price-quality ratio (14%, an increase of 6%). Opinions of social media (9%) and friends and family (5%, a decrease of 5%) are still important, but one can observe that sales of foreign goods/services are constantly being rationalized as the importance of factors such as price, quality (compared with the price, quality of domestic goods/services) increases.

The subsequent questions of the survey concerned the range of goods purchased abroad using stationary (computer, laptop) and mobile equipment (smartphone, tablet). In times of crises, clothing and footwear goods always take the first position in the ranking (Chmielarz, 2016). The abovesaid tendency is visible also in the present study. At the end of 2020, in the analyzed group of users, they accounted for the most (22%) purchases made using desktop computers. At the same time, this group recorded the largest decline in purchases, which amounts to over 8%. Similarly to previous studies, subsequent places were taken by cosmetics – 17% (always popular), as well as home electronics and household appliances – 14%. A nearly 4% increase in this area results mainly from the lockdown of internet users in their homes. If such a requirement existed, then users wanted – similarly to the case of Polish products – to stay in the most favorable environment. The fourth such group were gifts and gadgets, which were estimated at 12% (an increase of over 2%). Food products had an unprecedented share of 8% (an increase of over 4%) in the ranking. Until the end of that year, consumers bought mainly domestic products. Perhaps it was a result of fear related to possible shortages of some items on the market, especially in the first months of the pandemic and the first lockdown. In December 2020, the demand for books and sports goods bought abroad also decreased. These trends are illustrated in Figure 3.

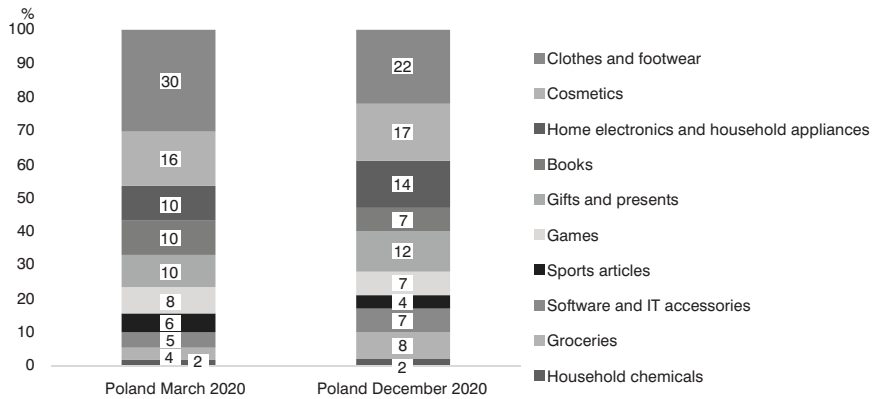


Fig. 3. Comparison of the assortment of purchases in foreign e-commerce in Poland in March and December 2020 using desktop and mobile devices. Source: Own study.

On the other hand, major changes took place in terms of the selection of foreign services purchased abroad. The biggest shift took place in the case of sale of airline tickets (a decrease of 20%, amounting to 2%.) There was also a drop of more than 10% in the area of tourist services (over 10%) and cultural services (12%). The demand for banking services increased from over 12% to 26%, similarly to insurance, medical and telecommunications services, The tendencies related to the demand for services before and during the pandemic via stationary devices is shown in Figure 4.

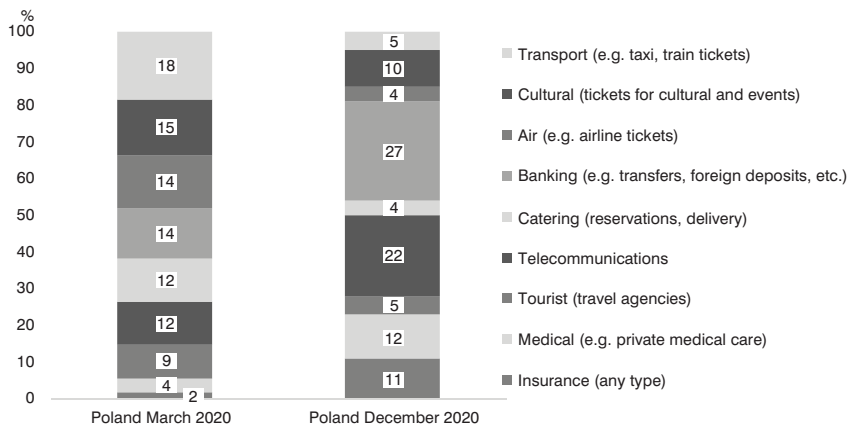


Fig. 4. Comparison of the selection of services in foreign e-commerce in Poland in March and December 2020 using mobile devices. Source: Own work.

The same tendency applies to services purchased using mobile tools. The greatest decrease in terms of interest was recorded in the case of the sale of airline tickets (over 10%) and transport tickets (13%). However, an increase was recorded in the case of banking (a rise from 14% to 27%) and telecommunications (a shift from 12% to 22%). A comparison of the situation in international mobile services in March and December 2020 is presented in Figure 5.

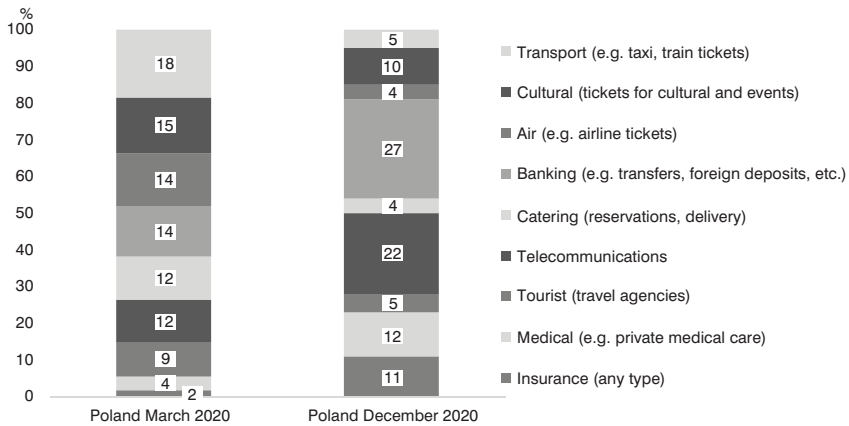


Fig. 5. Comparison of the selection of services in foreign e-commerce in Poland in March and December 2020 using mobile devices. Source: Own work.

A comparison of changes regarding the most popular types of foreign online services carried out via a smartphone (tablet, phablet) in March–December 2020 points to substantial differences. The largest decrease (over 13%) occurred in the case of the transport sector (train tickets, taxis) and air tickets (over 10%). The largest increase (above 13%) was recorded in the area of banking and telecommunications services (over 10%). The pandemic also caused an increase in insurance (9%) and medical (8%) services. However, a decrease was observed in the case of foreign tourist services (over 4%) and catering services (4%). These trends are illustrated in Figure 6.

The analysis of changes regarding foreign purchases related to specific sectors is carried out according to specific types of foreign products/services acquired via mobile devices in the period of six months of the study. The continued high position (23%) of purchases of clothes and shoes or cosmetics (16%) of foreign origin is an interesting phenomenon to be considered. The declined interest in online sales of domestic products related to these industries during the pandemic, signaled in the media (related to the fact that customers do not leave their homes and women use fewer cosmetics

because of the masks), is not confirmed by the present research concerning foreign purchases. However, an over 7% increase in the purchases of books, films and music (21%) seems natural considering greater demand for entertainment in the periods of lockdown. Also, buying household appliances could be explained by the fact that people staying at home notice the shortcomings of their equipment. The level of computer games sales remains unchanged and stands at 7%. However, remote work requires additional equipment and computer accessories, and thus an increase of 4% to the level of 10% related to foreign purchases may be observed in this regard. The largest decrease was recorded in the case of the purchase of plane, rail and bus tickets (a decrease of 10% to 5%) and tickets for entertainment and cultural events (of nearly 9%, amounting to 4%).

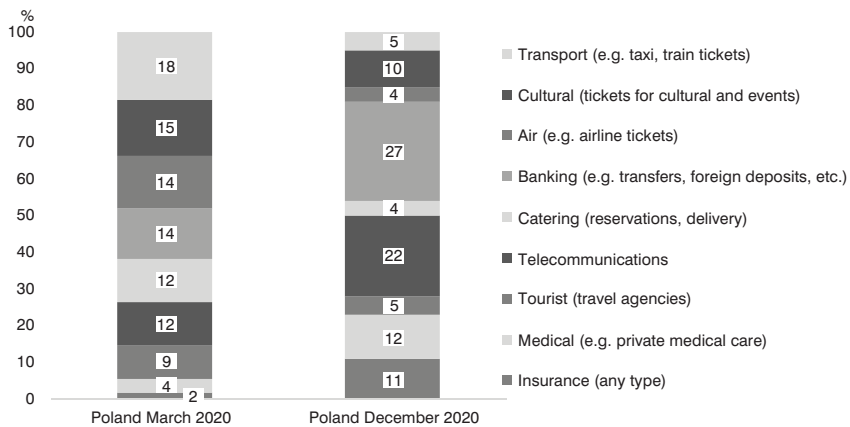


Fig. 6. Comparison of the services range in foreign e-commerce in Poland in the period March-December 2020 using mobile devices. Source: Own work.

The attitude towards products and services of foreign origin that respondents were ready to buy using a smartphone also changed. The COVID-19 pandemic significantly expanded the desire to use this method to purchase a wide range of products/services, also from other countries. While in the earlier period the respondents stated that they were not willing to make high-value purchases using m-commerce solutions, at present, they would be more open to considering this option. And while in March 2020, 14–20% of the respondents declared that they would not buy household appliances, IT equipment or tourist trips abroad this way, after nine months of 2020, the level of such indications decreased by half. In the case of other products, both goods and services, e.g. transport tickets, clothing and footwear, tickets for cultural events, there occurred a significant rise in the share of responses rejecting the possibility of making purchases

via mobile devices. However, in the comments section, the respondents tend to justify these claims with the fatigue caused by the general lack of variety in terms of available products/services, both in the case of online and traditional commerce. Interestingly, the opening of bookshops after the first lockdown period caused, for example, traditional sales of books and other products to double.

Another feature that differentiated online purchases abroad in this period was the method of payment. The structure of payments slightly changed, probably due to the increased necessity to shop online for products previously bought in a traditional way or using desktop devices (computer, PC). Also, the extension of the payment offer to other, often more convenient forms of electronic payment led to the abovementioned shift. As regards more expensive products/services, payments are still made mainly by card and by transfer (31% and 29% of transactions, respectively), while other purchases are mainly paid for with various forms of electronic money (amounting to 16%, an increase of 11% from March 2020). On the other hand, the rapid development of delivery services in the case of products ordered electronically caused a specific renaissance of traditional payments (18%).

The subjective assessment of the problems associated with the availability of foreign products/services has also changed significantly. More than 35% of respondents now believe that buying services/goods is very easy (a 10% increase), and a quarter of the survey participants state that it is as accessible as buying domestic goods. However, 29–30% of the respondents claim that the purchase of goods/services of foreign origin is slightly more difficult. Only 3% of the surveyed population consider such purchases to be difficult or too difficult and in need of promoting. It follows that in the analyzed period, the interest in international e-commerce grew and clients are now convinced of its relative ease and accessibility compared to domestic e-commerce.

Similarly to previous studies, the claims presented above may be seen as the confirmation and the evidence for the growing and accelerating globalization during the pandemic from the perspective of website-based and mobile e-commerce.

The results presented above, analyzed in terms of the differences between the findings obtained as part of the surveys conducted in March and December 2020, were supplemented with the Euclidean distance and city distance indicators. The indicators for the key questions contained in the survey are included in Table 1.

Distance indicators	City	Euclidean
Types of foreign products/services used on the internet via a smartphone (tablet, phablet)	81.9%	8.3%
The strength of the influence of IT on globalization	47.2%	8.1%
The frequency of purchases of products/services of foreign origin on the internet	42.0%	5.8%
Types of foreign products/services purchased using a computer (PC, desktop computer)	20.8%	4.3%
Types of payment used in e-commerce transactions in the purchase of foreign goods	41.6%	3.9%
Types of foreign products/services recently purchased using mobile devices	44.5%	3.2%
The degree of difficulty in buying products/services of foreign origin	30.8%	3.1%
Disadvantages of information technologies in globalization processes	38.2%	2.3%
Advantages of information technologies in globalization processes	31.2%	1.9%
Types of foreign products/services preferred in the case of mobile purchases	36.2%	1.9%
Premises of the greatest impact of electronic commerce on globalization	32.6%	1.8%
Types of foreign products/services preferred when making purchases using a computer (PC, desktop computer)	35.7%	1.7%
Manifestations of the influence of IT on globalization	33.4%	1.5%
The strength of the influence of e-commerce on globalization	19.5%	1.5%
Types of barriers to the development of international e-commerce	24.7%	1.3%
The basis for the decision concerning the purchase of goods/services of foreign origin instead of domestic products via the internet	32.6%	1.1%
The source of information on foreign products/services available on the internet	24.5%	1.0%
Types of articles of foreign origin purchased via mobile devices	25.9%	1.0%
The main obstacles in purchasing products/services of foreign origin using e-commerce solutions	32.4%	0.9%
The significance of barriers to international e-commerce	18.2%	0.7%
The clients' reactions after obtaining information from any source about foreign goods/ services	12.0%	0.3%
Distinguishing features of foreign products in e-commerce	6.8%	0.2%

Tab. 1. Indicators of the Euclidean and city distance for the results in March and December 2020. Source: Own work.

5. Conclusions

The findings presented in Table 1 lead to the following conclusions:

- the largest Euclidean distance (8.3%) occurs in the case of three indicators: the types of foreign products/services used on the internet via a smartphone (tablet, phablet), the strength of the influence of information technologies on globalization (8.1%) as well as the frequency of purchases of foreign products/services on the internet (5.8%);

- the smallest Euclidean distance occurs in the case of the following indicators: distinguishing features of foreign goods in e-commerce (0.2%), clients' responses after obtaining information about foreign products/services from any source (0.3%) as well as the significance of the barriers in international e-commerce (0.7%).

Thus, the most significant changes occurred in the case of the products/services range purchased abroad via the internet, the frequency of their purchase as well as the scope of their impact on globalization. These were changes either enforced directly by the limitations caused by the pandemic or indirectly – resulting from the need to stay at home or the desire to modernize one's immediate environment. On the other hand, one may observe the greatest consistency in terms of the simplest characteristics of foreign trade via the internet related to the recognition of a foreign product, as well as the way of and barriers to accessing it.

The changes that took place during the COVID-19 pandemic due to the relevant infrastructure changes (staying at home, remote learning, remote work, etc.) also extend and standardize the approach to e-commerce. The second equally important effect is the shift from desktop computers to mobile devices. Unfortunately, it is too early to establish whether this effect is permanent or temporary. After emerging from the crisis, a reverse trend or a specific counterreaction might occur. After the pressure to expand online activities decreases, we may be witnesses to a sudden reduction in the use of electronic commerce. The experience so far leads to the conclusion that in some fields of activity, following the period of using online services out of necessity for several weeks or months, some customers may want to turn away from the internet, considering it a meager substitute for reality. However, it does not seem to have any impact on the globalization processes as such.

The results of this article are intended for anyone interested in the impact of e-commerce on globalization in the era of the COVID-19 pandemic.

This study was subject to two types of limitations. The first limitation was due to the limited research sample described in section 3. Students are a group supporting globalization processes, where e-business solutions are widely applied. However, their purchases of products/services, including foreign goods, are often limited, especially when they are dependent on their parents' support in this regard. Nevertheless, they are usually pioneers in penetrating the internet, e.g. Chinese electronic markets.

Taking all the above into consideration, in order to increase the reliability of the results, the research sample should be extended in future studies to include representatives of other age groups. The research should also be internationalized and cover internet users from other countries. Hence, the direction for further development of the study is to carry out a comparative analysis of the attitude to globalization from the point of view of e-commerce customers in selected countries.

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ICT Solutions in the Activities of the Social Insurance Institution (ZUS) as an E-Administration. Evolution During the COVID-19 Epidemic (Case Study)

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Abstract

Purpose: As a case study illustrating the relationship between crisis management capabilities and the use of ICT techniques and technologies in public administration, the following text presents the evolution of selected ICT-based solutions used in the activities of the Social Insurance Institution (ZUS) as an e-administration and their use in the conditions of the COVID-19 pandemic. The article describes chronologically the most important projects in this area implemented and developed at ZUS from 2016 to the end of 2020.

Methods: To achieve the objective a case study method has been chosen, i.e. a method of a qualitative nature, which, among other things, allows for: an in-depth description of an atypical phenomenon, and also on a broader and individualized analysis of the problem, allowing for its better understanding. The application of the case study method for presenting the impact of the pandemic (global crisis) on the use of information technology – in accordance with the assumption of using this method in the so-called narrow approach – made it possible to reconstruct the course of this relationship and its conditions. The case description was based on the analysis of legal acts, ZUS documents: annual reports on ZUS activities, strategic studies periodically prepared in ZUS, specifying the current objectives, directions and instruments of its planned development, information publications available on the ZUS website and thematic information available in the media.

Findings: Using the example of the changes in the use of new techniques and information technologies in the Social Insurance Institution, it was shown how the process of automation and digitization was accelerated under the conditions of the pandemic. As a result, ZUS played the role of the main entity implementing government aid projects under crisis conditions. It is also a leader in e-administration development.

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Originality/value: The presented case study is an original paper, drawing attention to the potential of public institutions and conditions of its use in the global crisis situation. The added value of the study is the quotation of unpublished figures made available by ZUS. They enable an objective assessment of changes, the scale of described activities, as well as their effectiveness, measured e.g. by the number of activities, instruments and beneficiaries

Keywords: e-administration, ICT, crisis, COVID-19, Social Insurance Institution.

JEL: O3, O33

Rozwiązania teleinformatyczne w działalności ZUS jako e-administracji. Ewolucja w warunkach epidemii COVID-19 (case study)

Streszczenie

Cel: poniżej – jako opis przypadku ilustrującego związku między możliwościami zarządzania kryzysowego a wykorzystaniem technik i technologii informatycznych w administracji publicznej – przedstawiono ewolucję wybranych rozwiązań opartych na TI, wykorzystywanych w działalności Zakładu Ubezpieczeń Społecznych (ZUS) jako e-urzędu i ich zastosowanie w warunkach pandemii COVID-19. W treści artykułu opisano chronologicznie najważniejsze projekty w tym obszarze wdrażane i rozwijane w ZUS od 2016 r. do końca 2020 roku.

Metody: do realizacji celu wybrano studium przypadku, tj. metodę o charakterze jakościowym, które m.in. pozwala na: pogłębione opisanie nietypowego zjawiska, a także na szerszą oraz zindywidualizowaną analizę problemu, pozwalającą na jego lepsze rozumienie. Zastosowanie metody *case study* do prezentacji wpływu pandemii na wykorzystanie technologii informatycznych – zgodnie z założeniem zastosowania tej metody w tzw. ujęciu wąskim – pozwoliło odtworzyć przebieg tej zależności i jej uwarunkowania. Do opisu przypadku wykorzystano analizę aktów prawnych, dokumentów ZUS, publikacji o charakterze informacyjnym dostępnych na stronie internetowej Zakładu oraz informacji tematycznych dostępnych w mediach.

Ustalenia: na przykładzie zmian w zakresie wykorzystania nowych technik i technologii informatycznych w Zakładzie Ubezpieczeń Społecznych pokazano, jak w warunkach pandemii dokonano przyspieszenia procesu automatyzacji i cyfryzacji. Dzięki temu Zakład odgrywał w warunkach kryzysowych rolę głównego podmiotu realizującego rządowe projekty pomocowe. Jest też liderem w rozwoju e-administracji.

Oryginalność/wartość: przedstawiony opis przypadku jest opracowaniem oryginalnym, zwracającym uwagę na potencjał instytucji publicznych i determinanty jego wykorzystania w sytuacji globalnego kryzysu. Wartością dodaną opracowania jest przytoczenie niepublikowanych danych liczbowych, udostępnionych przez ZUS. Pozwalają one na zobiektywizowanie oceny zmian, skali opisywanych działań, jak i ich skuteczności, mierzonej m.in. liczbą działań, instrumentów i beneficjentów.

Słowa kluczowe: e-urząd, e-administracja, technologie informatyczne, kryzys, COVID-19, Zakład Ubezpieczeń Społecznych.

1. Introduction

The extremely dynamic development of information and communication technologies (ICT), linked to the increasingly common availability of broadband internet, has become a premise for using the potential of this change also in public administration. Among the declared objectives of building e-state, e-government or e-administration in Poland, there was no direct reference to situations requiring crisis management, and the epidemic

was certainly not among the expected threats. The implementation of new technologies in administration was – in general – justified by the need to improve the quality of customer service and efficiency in performance of its tasks¹, and the operational objective was to “replace paper culture with the electronic one”. Managers of public institutions stressed that this was the way to increase client satisfaction through a modern approach to process design and organization of resources. It was emphasized that in the new technologies implemented in the e-administration, the possibility of more effective management of public funds and coordination of inter-institutional activities are also important (Goreń, 2021, p. 31).

The global crisis caused by the COVID-19 coronavirus pandemic has radically changed the conditions of functioning of economies and societies. It modified the principles and forms of operation of organizations, the mode of decision-making or – in general – the ways of management (Weible et al., 2020, pp. 228–229; Oberoi & Singh, 2020). Crisis situations have occurred in both the private and public sectors at all levels. The negative impact of the pandemic was increased by its suddenness, the speed of its spread and – in fact – the surprise effect (Szyja, 2020). This is because mass morbidity was – in general – eliminated by widespread vaccination. For this reason, the probability of a global crisis in the form of a huge scale of morbidity and death was perceived as unrealistic, which in the field of management sciences is evident, among others, in studies on types of crisis threats (Stawicka, Wiśniewski, & Socha, 2011; Sienkiewicz-Małjurek & Krynojewski, 2010; Kuipers & Welsh, 2017). Indeed, many publications do not explicitly identify pandemic threats. Even in the area of dynamically developing security sciences, the likelihood of its emergence has given way, under the influence of real events, to threats of terrorism or cybercrime (Kuipers & Welsh, 2017). At the same time, health threats tended to focus on local crises and issues of access to medical care (Kuipers & Welsh, 2017, p. 277).

Due to the unidentified source of the SARS-CoV-2 coronavirus, it is currently not possible to clearly attribute the crises caused by it to a single crisis type. However, the mechanisms of crisis management in public institutions described in theoretical works, where the crisis is perceived as a threat to the security of citizens (Sienkiewicz-Małjurek & Krynojewski, 2010), have the form of largely universal principles. This fact and the flexibility of previously introduced operational solutions – including tools from the area of ICT, which were supposed to streamline the activities of administration offices as part of the development of the so-called e-government (Gonciarski & Mazur, 2017; MAiC, 2013)² – made it possible to apply them in the process of crisis management in the public sector in the conditions of a pandemic, allowing to mitigate its effects on citizens and the economy and to optimally implement statutory tasks by administration offices in a crisis situation.

The Social Insurance Institution is a public sector institution that has taken on a large number of additional, strategic tasks related to limiting the negative consequences of the pandemic in economic and social life – and at the same time fully implemented its basic duties towards citizens. It is one of the three main entities implementing the government anti-crisis programs, beside Bank Gospodarstwa Krajowego and the Polish Development Foundation. Its functioning seems to be a good example illustrating the relationship between crisis management capabilities and the use of ICT in public administration.

The Social Insurance Institution (ZUS) is – according to the statutory provision – “a state organizational unit with legal personality, carrying out tasks in the field of social insurance in Poland”³. Operating in the area of public finance, ZUS has the so-called critical resources at its disposal (see e.g. Walczak, 2009, p. 96 et seq.), bearing responsibility for the implementation of state guarantees in the area of social insurance, in particular with regard to the payment of insurance benefits. In fact, in implementing the obligations of the state, it bears responsibility for the social security of citizens⁴.

The Social Insurance Institution started building an e-structure using ICT solutions at the beginning of the second decade of the 2000s, bearing in mind not so much the objectives of crisis management as the need to improve the quality of customer service, reduce operating costs and streamline business processes (their computerization) (ZUS, 2010; ZUS, 2012). It was one of the first institutions in public administration to start implementing electronic solutions to improve customer service. In 2012, as a reward for its first initiative (Electronic Services Platform – PUE ZUS), ZUS received a title of ICT Leader, awarded by experts from the ICT industry who stressed not only the use of modern technologies, but also – which seems to be more important – a new way of thinking about managing an institution (PAP, 2012). Since then, ZUS has gradually introduced further ICT-based solutions and has consistently implemented its development strategy⁵.

However, a noticeable progress in the use of ICT in ZUS activities has been recorded since 2016. At that time, many reforms were implemented with a view to changing the method of collecting and settling social insurance contributions, introducing electronic handling of sick leaves, electronic data exchange between European social security institutions, and to facilitating contacts of institutional and individual clients with ZUS. These reforms were based on digitization and automation of processes (Uścińska, 2020a).

The explanation of the general mechanisms of operation of the so-called ZUS e-projects is important for showing their potential, which can be used in special, also crisis, situations. At the same time, the purpose of their introduction was indicated, which was originally not the efficiency of the institution under crisis constraints, and the purpose of their use under pandemic conditions was described. The evolution of ZUS Electronic

Services Platform, which was the first solution of this kind in the public sector, implemented in connection with the governmental program of building e-administration, is presented in this way. It was a baseline implementation for many ICT instruments consistently introduced by ZUS in subsequent years, the so-called ZUS e-projects, which are described further on. These are solutions related to the basic tasks of the Social Insurance Institution: collecting and recording insurance contributions (e-Składka), issue, circulation of and access to information included in medical certificates of temporary incapacity for work (e-ZLA), ZUS functioning in the system of EU institutions for social security and exchange of data in this area (the EU EESSI project, i.e. the System for Electronic Exchange of Social Security Information and the application wizard for certificates related to the social insurance of employees posted to work abroad, i.e. issuing the so-called A1 certificates).

The process of building the e-administration in Poland was quite slow. Apart from organizational and financial constraints, this was determined by a significant extent of digital exclusion of the society. Paradoxically, an unexpected and extremely difficult crisis, also for public institutions, caused by the COVID-19 epidemic, has significantly stimulated the process of implementing ICT solutions (Oberoi & Singh, 2020). The solutions which ZUS has been introducing for years with a view to performing its statutory tasks proved extremely useful. To a large extent, due to the possibility of using the previously developed ICT potential and thanks to quick decisions of the Management Board, which allowed this potential to be adapted to new, urgent challenges, ZUS was able – despite the restrictions caused by the epidemic – not only to carry out its statutory tasks in a consistent, steady way and without delays, but also to take over a prevailing part of the burden of organizational handling and paying benefits under the state programs for the protection of the economy, implemented during lockdown. This development of e-administration in crisis management is still ongoing. During the first wave of the coronavirus epidemic, the development of ICT solutions was even accelerated and substantial financial resources were allocated to this area. This was necessary due to an enormous scale of new, crisis tasks (Uścińska, 2020a).

Public sector institutions carry out huge tasks which require continuous modernization of their ICT. These have been continuously introduced, but the crisis caused by the coronavirus pandemic has, on the one hand, led to the implementation of new, hitherto unused methods of managing the functioning of the state and public institutions (narrow decision-making group, quick decision-making and direct implementation) and, on the other hand, has been a challenge for these institutions in the area of ICT. In 2020, there were many e-projects targeting millions of citizens. They were aimed at mitigating the impact of the COVID-19 pandemic, and, when properly managed, were used to upgrade ICT solutions. Using the example of the

changes in the use of new techniques and information technologies in the Social Insurance Institution, it was shown how the process of automation and digitization was accelerated under the conditions of the pandemic. This was also the result of courage and determination in managing and making decisions in this area under crisis conditions. However, the time of the pandemic was a circumstance favoring further development of digitization and computerization in subsequent areas of ZUS activity, of course with the use of timely and responsible management decisions. As a result, ZUS played the role of the main entity implementing government aid projects under crisis conditions. It is also a leader in e-government development.

The article describes synthetically the key ICT solutions implemented and developed at ZUS from 2016 to the end of 2020, drawing attention to the conditions and the way of their use in crisis for the implementation of various state aid programs related to the COVID-19 epidemic. The whole analysis ends with conclusions and recommendations, in which attention is drawn, *inter alia*, to the importance of the deliberate flexibility of these solutions, giving the possibility to use them in various crisis situations and for various purposes. Both the importance of strategic planning and the rapid and consistent implementation of such plans in ZUS development are emphasized.

2. Research Methods

According to M. Matejun (2011), “an important trend in management sciences is currently the use of qualitative methods, allowing for a more precise grasp of the specificity of phenomena and taking into account the influence of non-measurable or difficult-to-measure variables on management processes in modern organizations”.

To achieve the objective to which the following text has been subordinated, a case study method has been chosen, i.e. a method of a qualitative nature, which, among other things, allows for:

- a) an in-depth description of an atypical phenomenon. The atypicality of the described case results from the fact that ZUS is a public sector institution which started implementing the e-government program the fastest and to the largest extent, as well as a public sector institution implementing the largest range of activities that resulted from government aid, the so-called anti-covid programs, including especially the so-called anti-crisis shields⁶;
- b) a broader and individualized analysis of the problem, allowing for its better understanding (Slawinska & Witczak, 2008; Matejun, 2011, pp. 203–213).

The description of the changes introduced from 2016 in connection with the implementation of the ZUS development strategy allows for showing the importance of such features (elements) of public institution management as

the pace and consistency of implementation of planned activities, openness to new technological and organizational solutions, implementation of instruments with wide potential parameters of use, developed channels for the rapid flow of internal and external information, a clear division of tasks and competencies, and others.

The application of the case study method for presenting the impact of the pandemic (global crisis) on the use of information technology – in accordance with the assumption of using this method in the so-called narrow approach (Yin, 2009) – made it possible to reconstruct the course of this relationship and its conditions.

The case description was based on the analysis of legal acts, ZUS documents: annual reports on ZUS activities, strategic studies periodically prepared in ZUS, specifying the current objectives, directions and instruments of its planned development, information publications available on the ZUS website and thematic information available in the media. The numerical data illustrating the scale and dynamics of impact of the described projects are also an important element of the presented description. Some of the quoted information is available on the ZUS website in thematic tabs. The quoted unpublished data have been made available to the author by relevant departments of ZUS Headquarters.

3. ZUS Electronic Services Platform (PUE ZUS) – Base and ICT Development Potential During the Crisis Caused by the COVID-19 Epidemic

3.1. Electronic Services Platform as a Starting Point for Automation and Digitization of ZUS Services

The Social Insurance Institution provides services to over 25 million clients a year⁷, performing statutory tasks of different nature. It cooperates with many thousands of companies and institutions in Poland and abroad. The efficiency of this activity, bearing in mind all the stakeholders – as regards both the forms of cooperation and the pace of tasks performance – requires optimal use of modern solutions and coordination of activities of administration offices⁸. Due to the scale and variety of tasks, ZUS activities have perfectly fitted in with the objectives and directions of e-administration development in Poland⁹. In 2012, the Social Insurance Institution launched its ZUS Electronic Services Platform (PUE ZUS), which has been recognized by IT specialists as the best e-government project in Europe (ZUS, 2013, p. 4). This was a pioneering solution in public administration, and as a result ZUS has become the first Polish e-administration; although initially in a very limited scope of the functionality of this solution. However, already then, ZUS clients registered with PUE ZUS gained access to all their data stored

in ZUS databases. The first users registered on the Platform in mid-2012. In April 2015, a millionth user registered his account with PUE ZUS (ZUS, 2015).

Thanks to the cooperation with business and the media, PUE ZUS operated as expected. The information and promotional campaign of the Platform was conducted in most Polish TV stations and the largest radio stations as well as in Newsweek and Kurier TV. A special channel “Elektroniczny ZUS” (Electronic ZUS) was also launched in the YouTube movie service. PUE promotion, as well as the entire PUE project, was financed in 85% by the European Union under the Innovative Economy Operational Programme (ZUS, 2017a, pp. 45–47). In October 2016, the Electronic Services Platform of ZUS proved to be the most popular e-administration website in Poland and almost two thirds of the surveyed internet users declared their knowledge of this website. This was confirmed by the results of the opinion poll entitled “E-administration in the eyes of internet users” (online)¹⁰. Internet users stressed in this survey that it was very important for e-administration users to be able to settle their matters via the internet “from A to Z”, without confirming anything personally in the office. In response to these expectations and observing (in order to coordinate activities) e-projects of other public institutions, ZUS proposed to set up a trusted profile by e-banking – first on a pilot basis, and then successively providing this possibility to subsequent users of iPKO and Inteligo e-banking and other banks with which it has concluded appropriate agreements.

As the data contained in the annual reports on ZUS activities from 2016 to 2020 show, the platform has been developing over the following years in an evolutionary, systematic way, thoroughly prepared and tested. In this process, new functionalities are gradually added, which correspond to specific ZUS tasks, but also match the solutions introduced by other public administration institutions. Pensioners may verify the amount of their benefits, employees may check whether the employer pays contributions for them, and entrepreneurs have access to online settlements with ZUS. One can also use an old-age pension calculator, which will calculate the expected old-age pension on the basis of data recorded in one’s pension account and projections of future earnings (Uścińska, 2020a).

PUE ZUS functionalities have been adjusted to the needs of various groups of ZUS clients. With time, all persons who have opened an account on the PUE portal, apart from access to their data, also gained an opportunity to “contact ZUS the other way”: transferring insurance documents to ZUS, filing applications and receiving decisions concerning them, asking questions and receiving answers as well as making appointments (ZUS, 2018a; 2019; 2020f; 2021e).

Since 2016, ZUS computerization has been a key priority for ZUS development (ZUS, 2015a). Data contained in cyclical reports on ZUS

activities indicate that the potential of the platform is being used more and more extensively and dynamically. The following years have been a period of PUE expansion, with acknowledging, inter alia, the effectiveness and speed of information transfer, i.e. elements enabling operation in crisis (see e.g. Gołębiowski, 2015; Walczak, 2009). The lower costs of such transmission are also important. The platform is still gaining new users, which is happening with the large participation of ZUS employees, who are creating PUE accounts at the headquarters of companies.

As the 2017–2019 reports on ZUS activities indicate, since 2017, PUE ZUS has been used – as an alternative way to apply for support – in projects related to the payment of social and family benefits (e.g. the 500 plus child-support benefit). Many new functionalities were introduced in 2019 (e.g. an opportunity to file an application for a certificate of absence of arrears in contributions payment and to receive such certificate via PUE – it is an important document conditioning decisions in many external activities of companies).

Since 6 February 2020, almost on the eve of the announcement of an epidemic emergency, and then a state of epidemic connected with the introduction of the lockdown, a new method of signing documents – personal signature – has been made available on PUE ZUS¹¹. The signature was attached to key e-administration solutions: trusted profile (PZ e-PUAP) and qualified electronic signature, and in selected cases – the possibility of signing electronic documents with the PUE profile. Another solution advantageous for platform's clients results from gradually introduced compatibility of projects creating an increasingly wide range of e-administration in Poland (ZUS, 2020d).

Restrictions in social and economic life caused by the coronavirus epidemic confirmed the need to create new ICT solutions in public administration and to develop cooperation between institutions in order to ensure the compatibility of these solutions. During the epidemic, PUE ZUS, which has been developed in a systematic manner since 2012 and improved in terms of functionality and use of subsequent ICT mechanisms, proved to be a key element of the implementation of basic state aid programs limiting the negative effects of lockdown; also those activities and forms of support which are not related to the statutory tasks of ZUS (Uścińska, 2020a).

3.2. ZUS Electronic Services Platform (PUE ZUS) During the COVID-19 Epidemic

In March 2020, only ZUS had sufficient potential and experience in implementing ICT solutions on a nationwide scale, covering millions of clients. ZUS actively participated in developing state aid programs for the economy and labor market protection, in particular the so-called anti-crisis shields. It also became their main implementing agency. The proven functionalities of the PUE and the potential of the Complex Information

System (KSI) provided the basis for fast, large-scale actions, which determined the effectiveness of the support provided (Uścińska, 2020a).

Immediately after the announcement of the lockdown and the first anti-crisis shield (March 2020), ZUS was handling requests for exemptions from paying social insurance contributions (which concerns the area of ZUS statutory tasks). In addition, ZUS accepted requests for downtime benefits, solidarity allowance and other benefits and was paying them (Łuksza, 2020). The scale of additional tasks, including the payment of an additional care allowance for parents of children under 8 years of age, and the required pace of handling each of the support solutions have never been verified in any PUE test. As a result of the significantly increased activity of management and ICT teams and the involvement of executive teams, the support program was implemented based on nine successive anti-crisis shields (Biuro Prasowe, 2020).

Quick decisions of the ZUS Management Board and their immediate implementation, including those related to the adjustment of PUE functionality to the requirements of the support programs, as well as the technical capabilities of the platform, created with a view to its constant expansion and improvement, allowed the assumed tasks to be performed during crisis. From March 2020 to August 2020, ZUS paid out 2.5 million downtime benefits in the total amount of PLN 5.5 billion, accepted 2.1 million requests for exemption from contributions and considered requests of about 2 million persons in the amount of about PLN 13.5 billion, paid additional care benefits in the total amount of PLN 3.5 billion and solidarity allowances in the amount of PLN 1 billion. In parallel with these additional tasks, ZUS continued to carry out all its regular statutory tasks in the area of social insurance on time (ZUS, 2020e).

During the epidemic, ICT solutions, especially those using PUE ZUS, are moving towards dynamic automation of processes and electronic information exchange as well as sharing databases between administration offices. ZUS is also introducing solutions limiting – to a necessary minimum – the participation of clients in the process of establishing rights and paying benefits. For example, it obtains on its own, from the Civil Registry Office, certified copies of vital record needed to pay maternity allowances and funeral grants (ZUS, 2020g). The sending on an annual basis of millions of letters to insured persons with information about their account balance has been replaced, since July 2020, with the possibility of checking this information on PUE, and only persons who apply for it will also receive this information in the paper form. The Platform also allows for appointing a visit, and from October 2020, also e-visit in ZUS, at the same time prompting the address of ZUS unit which corresponds to the client's address (ZUS, 2020).

As a result of the positive results of downtime benefits payment by the Social Insurance Institution, ZUS has been entrusted with another obligation

outside its statutory tasks: payment of the solidarity allowance. Due to the fact that ZUS has databases enabling quick verification of entitlements, the request for this form of assistance could only be submitted electronically via the PUE ZUS portal (ZUS, 2020a). This portal was also made available to entrepreneurs involved in tourist trade and public benefit organizations to allow them to apply for participation in the Polish Tourist Voucher program (ZUS, 2020j). More than 18 thousand entities submitted via PUE their declarations for entry into the list of entities entitled to accept payments with the voucher by the end of 2020 and by June 2021 – more than 23,000¹².

4. ZUS E-Projects and Their Role During the Pandemic

4.1. The Rationale for Implementing ZUS E-Projects

Information from ZUS annual reports¹³ shows that since 2016, a number of reforms have been implemented in the Social Insurance Institution, related to ZUS main statutory obligations (change in the method of collecting and settling social insurance contributions, introduction of electronic handling of sick leaves, electronic data exchange between European social security institutions, measures facilitating contacts between institutional and individual clients with ZUS). These reforms were based on digitization and automation of processes, and their effects created the foundations on which, during the epidemic, solutions supporting the Polish economy were built in a very short time, ensuring – as experience during the pandemic has shown – the possibility of surviving an extremely difficult time.

During the epidemic, it was the automation of customer service that proved to be the key to the efficient functioning of the Social Insurance Institution (which was already an e-administration to such a large extent), and created the possibility of an efficient response to the expectations of the environment by quickly expanding the scope of tasks and the pace of service (Osiecki, 2020). Earlier implementation of ZUS e-projects, planned as development, long-term initiatives, changing (and/or modifying) their mechanisms according to the evolving needs of various stakeholder groups, significantly facilitated and accelerated the processes of their adaptation to new tasks, directly resulting from the COVID-19 epidemic (Osiecki, 2020).

4.2. e-Contribution

From 1 January 2018, the Social Insurance Institution has introduced changes to the rules for the payment and settlement of social insurance contributions (ZUS, 2019). Contribution payers were awarded by ZUS individual contribution account numbers (the so-called NRS), to which they pay contributions for social insurance, health insurance, the Labor Fund, the Guaranteed Employee Benefits Fund and the Bridging Pension Fund (depending on which insurance types and funds they are obliged to pay

contributions to) in one transfer. The work related to the preparation of the NRS was carried out in cooperation with the National Bank of Poland and its ICT system. A new method of electronic communication between ZUS and NBP was implemented, enabling automatic handling of statements containing analytical information about payments made. Technical assistance was provided to handle possible errors in ICT systems and in software as well as in files downloaded from the bank. The transition from the settlement system valid until the end of 2017 to the new system went smoothly and without disturbances (*ibidem*).

All information concerning the payer's account balance can be found on PUE ZUS.

The introduced solution proved to be beneficial in many areas. E-contribution made it easier for payers to conduct business activity by simplifying the procedure of due contributions payment (one transfer to one bank account instead of several transfers to several accounts), eliminating excessive information when filling in the payment document thanks to the introduction of simple identification of payments by the individual contribution account number, which reduces the possibility of error, faster and cheaper procedure of contributions payment, quick access to information on money paid to ZUS and its distribution among individual funds (ZUS, 2021c). For ZUS, the positive effects of e-contributions mainly include a much smaller number of incorrectly filled transfers (from several thousand per month to several dozen or so). The smaller number of incorrect payments translated into a much smaller number of investigations which were initiated in the case of incorrect transfers, which was labor-intensive and generated costs (ZUS, 2017).

In the context of crisis management, the e-contribution should be assessed as a solution enabling the efficient, coordinated management of financial resources (Walczak, 2009, pp. 95–96). It resulted in “sealing” to large extent the contributions collection system and thus improved the financial condition of the Social Insurance Fund (SIF), from which most benefits are paid to persons insured. During the first two months of operation of the described solution (i.e. until the end of February 2018), revenues from contributions were by almost PLN 3.5 billion higher than in the same period of 2017. The SIF has improved financially, which means lower expenditures on benefits from the state budget (ZUS, 2018b).

The implementation of the e-contribution also facilitated the identification of payments and their faster settlement on the payers' accounts. Organization of accounts allows, *inter alia*, for their quick assignment to a person (payer), and the streamlining of procedures related to the collection and settlement of contributions enables further development of services for clients as well as simplifies and improves the efficiency of the social insurance system. This, however, required significant changes in the Complex Information System of the Social Insurance Institution and the preparation of ZUS employees

for handling e-contributions. The information system allowed for handling mass payments and carrying out an automatic distribution and settlement of payments on payers' accounts. The new software assigns NRS numbers and allows for sending notifications about their assignment. At PUE ZUS, the payer may check his or her NRS, see how his or her contribution was distributed and what is the balance of his or her account (ZUS, 2020f).

Simultaneously with the implementation of e-contributions, contribution payers' counselors were appointed. They operate in the customer service halls and assist the clients in registering their business activity as well as inform them about the rules of reporting to insurance, the amount of contributions and the rules of completing and correcting documents. This group of counselors also provides all information about the payer's account available on PUE. To a large extent, contribution counselors play the role of an "emergency solution" when the payer is unable to use the e-contribution function (MRiPS, 2018).

The simplification of the method of social insurance contributions payment during national lockdown facilitated the possibility of settling the payers' obligations towards the Social Insurance Fund without the need to contact ZUS in person. At the same time, payers who have problems with using ICT solutions have an opportunity to take advantage of the counselor's support in a ZUS branch. When restrictions on visits to institutions and offices were introduced, ZUS indicated the possibility of using the Telephone Service Centre (COT), but also introduced e-visits (Uścińska, 2020a; ZUS, 2021a) – the possibility of booking online contact with a ZUS employee in a specific case – which met with rapidly increasing interest. The rules for settling contributions and organizing accounts thanks to the e-contribution gave the payers an opportunity to quickly assess their entitlements to take advantage of the exemptions from paying insurance contributions proposed by the government. From the perspective of ZUS and the government, the up-to-date – thanks to NRS – Central Register of Contribution Payers made it possible to precisely assess the scale of necessary costs of assistance granted to entrepreneurs with regard to insurance burdens. Moreover, the current information on the status of payers' accounts allowed for the reimbursement of overpayments, resulting from periodic exemptions from contributions payment, without submitting applications for this (ZUS, 2021).

The organized balance of insurance accounts also proved to be a key element in assessing the economic condition of the country. Changes in the number of contributions paid are the basic source of information about the existence or liquidation of companies, about changes in the labor market or about the amount of salaries. From the perspective of ZUS, this information is an essential element in assessing the condition of the Social Insurance Fund – its balance sheet and the amount of the budgetary subsidy, necessary to ensure the Fund's financial liquidity (ZUS, 2021b). This knowledge is crucial to guarantee the Fund's solvency, which has often been asked about

in the media debate in recent months in the context of the security of benefit payments to pensioners (Sawulski, Magda, & Lewandowski, 2019; Raudner, 2019).

4.3. Electronic Certificate of Incapacity for Work (e-ZLA)

Another ICT solution implemented in ZUS, which proved to be crucial during the state of epidemic, are the electronic medical certificates of incapacity for work (the so-called e-ZLAs), i.e. sick leave certificates issued electronically.

The possibility of issuing e-ZLA existed from 1 January 2016. However, most doctors have not used this solution and issued sick leaves in the paper version (ZUS, 2017a). The employee was obliged to deliver such a certificate to ZUS within 7 days from the date of its issue, and the issuing doctor had to periodically submit one of three copies of the certificate to ZUS, which recorded the certificate and entered it into the relevant database (ZUS, 2016).

In order to improve the flow of information on sick leaves to each of the parties concerned: employee, employer, doctor and insurance body, from 1 December 2018 the legislator introduced an obligation (used from 2016 as a voluntary solution) to issue sick leave certificates only in the electronic form (ZUS, 2019). A doctor fills in an electronic form, which is connected to the ZUS information system. After filling in the form (this happens automatically to a large extent thanks to ZUS databases), the doctor signs the certificate. There are 3 possibilities to sign it. The first one is a ZUS certificate (in operation since 1 December 2017), renewed every 5 years and downloaded by the doctor from PUE ZUS (ZUS, 2018a). The second possibility is a qualified electronic signature, which is issued by authorized certification centers. The third possibility is a signature confirmed by the ePUAP trusted profile, which replaces the handwritten signature in electronic documents. This free method of confirming identity is used in electronic administration systems.

It should be noted that various electronic devices may be used to issue electronic certificates of temporary incapacity for work, e.g. notebooks, tablets and mobile phones, which does not limit doctors to work in a doctor's office only. Moreover, the process of issuing a certificate is supported by a wizard which guides the doctor step by step, and the system verifies, inter alia, the correctness of the dates entered, which is important for the payment of benefits for the time of sickness. The completed e-ZLA form is submitted electronically to ZUS, which shares it with other stakeholders, including employers. A doctor may issue a certificate for a patient, a certificate for a carer, a certificate for a previous period and may also cancel the document issued (ZUS, 2018).

E-ZLA, as an obligatory solution, was introduced with some resistance of the medical community, which indicated, inter alia, the local restrictions

on internet access (in response, ZUS introduced emergency procedures, inter alia, allowing the e-ZLAs to be sent to ZUS within 3 days from the date of their issue) and the insufficient digital skills of some medical staff, because a large proportion of doctors are over 60 years of age (ZUS came up with a proposal of training the medical staff, also allowing the e-ZLA certificates to be issued by medical assistants of doctors authorized to issue them) (see e.g. ZUS, 2018; Janoś, 2018). The cooperation of ZUS with the Ministry of Health and with business contributed to the modernization and adaptation of the so-called cabinet applications to the requirements of e-ZLA (ZUS, 2020f).

Since 1 December 2018, electronic certificate has been an obligatory form of medical certificates of incapacity for work. On the occasion of this project, ZUS has for the first time entered into a very extensive interaction with clients and for the first time has undertaken so many activities outside its own facilities.

The main measure of project effectiveness is the 99% share of electronic certificates among all medical certificates of incapacity for work issued in a given period. For comparison: one year before the statutory obligation to issue e-ZLA was introduced, only 6.4% of medical certificates of incapacity for work had been issued in the electronic form¹⁴.

During the epidemic, the benefits resulting from the use of e-ZLA (a solution, which is inter alia embedded in a broader system of medical care, coordinated and interoperable therewith; see Gołębiowski, 2015) proved to be difficult to overestimate in many dimensions; also in the context of their functioning in the system of changed principles of medical care and the prevalence of teleadvice or televisits introduced by the Ministry of Health. Without e-ZLA, these solutions, necessary when personal contacts must be limited, would have extremely limited possibilities of application. Automatic, quick transmission of information about sickness, quarantine or the use of child-care leaves to ZUS and to the employer has made it possible to pay benefits efficiently and has facilitated optimal management of employment in companies and institutions. An employer who has a profile established on the Electronic Services Platform receives immediate information about the employee's absence. What is also important, employees have been released from the obligation to deliver certificates to their employer who has a profile on the PUE. If the employer has not set up such a profile, unfortunately, such an obligation is still incumbent on the employee, although the seven-day deadline does not apply here. That is why, among other things, ZUS provides employers with information on the possibility of setting up accounts at PUE ZUS and offers online support in this process¹⁵.

The multitude of cases and the volatility of the law increases the risk of ZUS employees' mistakes in customer service. For this reason, inter alia, since 30 September 2020, a general application (POG) has also appeared at PUE ZUS: a form by means of which an explanation, a complaint or an

application may be submitted to ZUS. Such a letter may be accompanied by an attachment of a certain size (up to 5120.00 KB) (ZUS, 2020i). This is one of the last ICT solutions introduced by ZUS by the end of 2020 in the crisis mode, when it is necessary to limit personal contacts with the client. Projects of this nature were included in ZUS development strategy (ZUS, 2015a), but the crisis challenges for the functioning of ZUS as a public institution during the restrictions resulting from the epidemic speeded up their implementation, taking into account, however, the possibility of their modification and extension of the scope of functionality – a margin for flexible reaction in unexpected conditions (Ratajczak, 2021).

5. Suitability of ICT Projects Related to the International Activities of ZUS During Epidemic

5.1. E-Projects in the Implementation of International Tasks of ZUS

The above-described components of ZUS information system focus on its national tasks. However, when due to the epidemic the direct accessibility of the institutions for their clients is restricted, ICT-based solutions have become of significant importance. Thanks to them, ZUS can carry out these tasks on an ongoing basis, and this also concerns its statutory international obligations. Their performance results, *inter alia*, from ZUS's function as a 'competent institution' in relation to the obligations of the state in ensuring the realization of EU rights and freedoms, including the freedom of movement of citizens, residence and work in other EU countries and ensuring the right of Polish citizens abroad to social security benefits. The scope and forms of ZUS's activities in this area generally result from regulations and decisions of international institutions, but ZUS also undertakes its own projects aimed at improving the quality of customer service, e.g. by applying ICT solutions¹⁶.

5.2. Electronic Exchange of Social Security Information (EESSI)

From 1 July 2019 the Social Insurance Institution – as the first among competent institutions from 32 countries – introduced the system of Electronic Exchange of Social Security Information (EESSI). This project resulted from the need to implement the regulations on the coordination of social security systems in the European Union and the European Economic Area EFTA countries (ZUS, 2019a).

The system allows for faster and more efficient cooperation between social security institutions of EU Member States in handling individual cases, and facilitates the process of controlling receivables and eliminating abuse in the use of benefits. Prior to the implementation of EESSI, appropriate modifications were made in the Complex Information System of the Social Insurance Institution (KSI) and its operation was subjected to multiple tests,

both within domestic relations and in contact with a foreign institution (ZUS, 2021f).

EESSI is a working tool designed for 8 thousand national social security institutions (the so-called contact points), which annually serve a total of over 14 million beneficiaries (EC, 2020). The system is used for the exchange of data on benefits (pensions, allowances) and the application of legislation (including issues related to the posting of workers, which concerns workers from Poland, to the largest extent in the EU). The system also covers health benefits provided by the National Health Fund, family and unemployment benefits, for which the Ministry of Family and Social Policy is responsible. In addition, ZUS tasks include the transfer of information related to the social insurance of farmers and insurance in uniformed services. The electronic exchange of data concerns information, documents and declarations (scans) necessary for the handling of cases (EC, 2020; Frączak, 2021).

The use of ESSI is a classic departure from paper documentation in favor of its electronic form. Social security institutions of EU Member States exchange standardized documents in this way on the basis of jointly agreed procedures. Thanks to an electronic register of all EU social security institutions, electronic documents are sent to competent officials in another Member State.

The electronic exchange of information has shortened the handling of cases. Standardized forms make it possible to eliminate errors, to obtain correct and complete data quickly and to remove language misunderstandings. EESSI has allowed for better quality and more efficient operation of the institutions (the system is not aimed at direct customer service) (jk, 2019).

Restrictions introduced due to the spread of coronavirus in the case of Poland, among others, seriously disrupted the possibility of performing work by cross-border employees (living in Poland and working in a neighboring country). They also aroused anxiety among employees and employers as to the employee rights and social rights to which they are entitled in quarantine. In such unexpected situations, uncertainty arose as to the previously binding procedures. Cooperation between institutions within the EESSI framework provided a guarantee of continuous, fast, secure and standardized electronic exchange of information and the possibility – despite the restrictions introduced due to the pandemic – of handling cases concerning cross-border cases of social security coordination.

Between 1 July 2019 and 31 May 2020, a total of around 10,000 electronic documents were sent and received. In the fourth quarter of 2019, there was an increase in the number of messages exchanged due to the launch of production exchanges by successive EU/EFTA countries on selected business use cases (BUC). Since 1 June 2020, following the start of exchanges for all EESSI processes, there has been a rapid increase in the number of documents received, reaching 207,000 documents. However, the potential

of EESSI is still to be exploited: the target daily number of exchanged messages could be around 5,000¹⁷.

5.3. Application Wizard for A1 Certificate

In pursuing its development strategy, ZUS considers the implementation of automation and computerization of processes related to the improvement of customer service quality to be a priority, also during epidemic (ZUS, 2015a, p. 8). The pandemic highlighted the importance of the availability (understood in a multidimensional way) of an electronic procedure for dealing with matters “from beginning to end”, while minimizing the involvement of contribution payers and insured persons.

The information published on the website of the Social Insurance Institution (News) shows that before the introduction of restrictions in Poland as a result of the state of pandemic, as well as during the pandemic, ZUS developed and then implemented further ICT projects to improve its operations. While implementing EESSI, ZUS joined the international network of cooperation between institutions; since the end of September 2020, it has launched its own project – related to the performance of work abroad by Polish citizens – extending the scope of automated customer service activities. New solutions have been implemented at PUE ZUS for persons who apply for the A1 certificate confirming their social insurance coverage in Poland (ZUS, 2020h).

Since 5 February 2020, ZUS has made 7 new applications for the A1 certificate available to clients, corresponding to different situations. The procedure of issuing the A1 certificate had thus far included the submission of paper applications in selected branches of the Social Insurance Institution. Since 30 September 2020, clients who wish to obtain the A1 certificate can do so at PUE ZUS, where they have access to all applications related to the issue of the certificate (ZUS, 2020h). Electronic forms have been implemented in a new simplified version and have the form of a wizard which guides the client through the process of filling in an intuitive way. The system automatically recognizes, on the basis of the information provided, which type of application is appropriate for the situation. The wizard, which is a new solution in ZUS, meets the current needs and procedural limitations resulting from the sanitary regime and restrictions caused by the coronavirus pandemic. It enables application for A1 in the most typical situations related to professional activity abroad (posting of a worker to another EU, EEA Member States or Switzerland, temporary transfer of an activity as a self-employed person or performing an activity as an employed person in another country or an activity as a self-employed person in several EU, EEA Member States or Switzerland) (ZUS, 2020c).

During the pandemic, such advantages of the solution as the speed of customer service and the efficiency of ZUS units responsible for issue of A1 certificates were strengthened. The creation of a set of documents in the

wizard significantly shortens the time needed to complete the application, which was positively received by the payers. The shorter service time means at the same time the release of employment potential and the possibility of its use also for the new ZUS tasks, imposed by the crisis state aid programs.

Within four months since the introduction of the possibility to apply for the A1 certificate electronically with the use of PUE, ZUS has received 130,000 applications concerning this matter, which, in the context of restrictions on labor mobility caused by the pandemic, is a significant number¹⁸.

The introduction of an electronic procedure for obtaining A1 certificates in such a difficult period has many positive aspects. The solution is tested in extremely difficult circumstances, and, at the same time, the necessary safety margin has been maintained, because the conditions for potential modification of the solution are more favorable, as we are dealing with an external restriction on the possible scale of application for these documents. Until the return to full freedom of movement for workers and conducting business activity abroad, it is possible to eliminate possible errors in this solution with limited side effects.

6. Summary, Conclusions and Recommendations

The COVID-19 epidemic have contributed to the emergence of multi-faceted (global) crisis which appeared in an absolutely surprising way for social and economic life. Public entities which are not involved in the process of economic competition also feel the constraints and challenges of carrying out their own tasks during the epidemic. In the changed realities of operation, it has become necessary, among others, to make maximum use of resources that must be accompanied by efficient management and quick decisions, which must be translated into practice without delay. These are not typical behaviors for the public sector, where, inter alia, e-administration mechanisms were introduced quite slowly. The offer of e-administration services may be a factor motivating society to make greater use of ICT. It may also be one way of reducing digital exclusion (Arcimowicz & Gadowska, 2020).

The pandemic has changed the perception of digitization and automation in all sectors (Grocki, 2020; Arcimowicz & Gadowska, 2020). For public institutions, the criterion determining the implementation of ICT (often in an emergency mode) has become not so much the savings and quality of service as the possibility of carrying out the tasks assigned to them. Flexibility in management and operation has become necessary (Kisilowski, 2019). Gradually, reluctance and discomfort in society, as well as fears of using ICT have given way to the benefits experienced. It turned out e.g. that remote working can be efficient, that it is possible to effectively deal with the matter in the office without leaving home, that one does not have to wait in queues at the cash register to do shopping, and that one

can get dishes from his or her favorite restaurant straight to his or her door. There have been rapid, significant and irreversible changes in the functioning of the economy and the society; changes in mechanisms and attitudes (EC, 2020). This is a feature of the crisis. People have learnt to use digital space on an unprecedented scale and have begun to expect further changes (Szyja, 2020).

Crisis management in the public sector is an area whose definition and functioning raises many questions and controversies (Walczak, 2009, pp. 95–96). However, both theoreticians and practitioners stress that it is about planning and integrating activities of different nature (organizational, financial, logistical), aimed at preventing the emergence of crisis¹⁹. Their aim is to ensure the efficiency of decision-making structures at all levels of governance, the continued readiness of forces and means to take action, to react efficiently and to deal with the consequences of the situation (Szyja, 2020, pp. 271–272; Walczak, 2009, p. 96).

In Poland, the unforeseen COVID-19 epidemic has led to a situation that can be fully described on the basis of the above definition. Another manifestation of crisis management in the Social Insurance Institution can also be considered to be successive decisions of the ZUS Management Board taken since the beginning of March 2020 in response to the needs of the moment, which quickly and effectively resulted in the evolution of solutions towards the implementation or modification of strategic projects carried out by means of ICT, and aimed at the complete transformation of ZUS into an institution integrated with other public organizations, automated, digitized, responding efficiently to government decisions aimed at limiting the negative effects of the epidemic. Using the experience resulting from the previously introduced ICT solutions and the gradual accustoming of clients to electronic solutions, ZUS effectively mobilized them (in an increasingly radical way and, finally, forcing them to use electronic solutions – see the obligatory submission of applications for support on PUE) to overcome fears of change or barriers of ignorance.

In the public debate on the effects of the epidemic, the acceleration of the process of digitization of services and the limitations of digital exclusion are often indicated. For example, in terms of profiles set up at PUE ZUS, which are necessary to use many of the platform's functionalities, statistics show that at the end of May 2021 there were almost 7 million profiles, while at the end of November 2019 – 3.3 million. Between March and November 2020, 2.4 million new profiles were created, which means that during the pandemic their number almost doubled²⁰.

By implementing new ICT-based solutions and expanding or modifying previous solutions, ZUS has responded to the needs for managing the institution during crisis: “increasing the speed of decision making and the pace of change adjusted to the pace of social and economic changes enforced by the progress of civilization and technology. In the implemented projects,

persons deciding on the directions of institutional development have noticed early enough the need to integrate and expand the competences of public institutions in the area of social and economic space management in the areas of knowledge and information, education and training, economic and social legislation, protection and management of resources (...)”²¹.

All ICT solutions used in ZUS have a prospective element in their structure: a certain potential to be used in the situation of changes in operating conditions and the appearance of new tasks. The evaluation of this potential also includes human capital in the institution (Goreń, 2021). The projects using ICT in ZUS – the development priority of this institution (Uścińska, 2020) – have been developed in a systemic perspective, taking into account the role of ZUS in e-administration and the context of cooperation with other institutions and with business. The time of crisis management during the epidemic, although not explicitly provided for in the concept of these projects, has shown the value (usefulness) of such an open approach (Zawiła-Niedźwiecki, 2020).

One of the general conclusions that arises both from the analysis of the literature on crisis management and from the case study presented above illustrating the relationship between solutions from the field of ICT and the management of an organization in the conditions of a global crisis is the need for a more open approach in building systemizing theories in crisis management, on the basis of which the principles, objectives and instruments of crisis management are defined. The validity of such an approach is proved by the widespread surprise caused by a global crisis. The pandemic has radically changed the economic and social conditions and relations on a global scale, forcing the ad hoc combination of the developed crisis management procedures in defined types of crises (in conjunction with the theory, which did not distinguish global threats of this nature) with current challenges²².

The dissimilarity (scope) of the objectives of crisis management in business and in public administration justifies the distinctness of the principles and instruments used in crisis situations in both sectors. What crisis management in the public sector expects in the context of developing IT (e-government) includes:

- flexibility in terms of tasks performed by individual public institutions (possibility to accept tasks of other institutions, less prepared to function in crisis conditions);
- efficient communication (defined rules for cooperation and safe and efficient flow of information/data between institutions);
- compatibility of ICT solutions implemented in different areas of functioning of public administration. Only the first steps have been taken in this area, although e-government instruments have been implemented in individual institutions for over a decade (Zawiła-Niedźwiecki, 2020, pp. 97–99).

What is needed – and importantly consistently implemented – is strategies for the development of individual institutions, aimed at their development through the implementation of modern, flexible (with a high potential for development) ICT solutions. They should be an element of synchronized systems of performing specific public tasks, allowing for:

- efficient, synchronized performance of tasks of the whole public sphere under “normal” conditions;
- protection of citizens in a specific area in crisis situations;
- leveling organizational rigidity of the public sector (the so-called sectoral nature of activities);
- helping to assess the effectiveness and efficiency of tasks undertaken and instruments used.

The assessment of the Social Insurance Institution’s activities made on the basis of the case description both before 2020 (the period of building rules and solutions allowing for better and better quality of task execution) and during the pandemic, as well as the necessity to implement tasks resulting from the occurrence of the crisis seems to confirm the legitimacy of such recommendations.

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Endnotes

- ¹ Such a justification is indicated, for example, by the strategic documents of public agencies and reports of the Supreme Chamber of Control, which evaluate their activities.
- ² See also the text of the Act of 17 February 2005 on the computerization of the activities of entities performing public tasks (consolidated text Journal of Laws 2021, No. 670, as amended).
- ³ The status of the Social Insurance Institution has been defined in Chapter 7 of the Act on the Social Insurance System (consolidated text Journal of Laws of 2020, item 266 as amended).
- ⁴ The statutory tasks of ZUS concern not only the implementation of state guarantees towards the insured, but also the payment of non-insurance non-contributory benefits (e.g. social pensions, supplementary benefits for persons incapable of independent existence, child-support benefits, solidarity benefits for the unemployed and others).
- ⁵ This is confirmed by information from the annual reports of the Social Insurance Institution on the performance of tasks in consecutive years in the period 2016–2020, available on the website www.bip.zus.pl under the tab “Sprawozdania z działalności ZUS” (Reports on ZUS activities).
- ⁶ Act of 31 March 2020 amending the Act on special solutions related to preventing, counteracting and combating COVID-19, other infectious diseases and crisis situations caused by them and some other acts, Journal of Laws No. 568 as amended; Act of 16 April 2020 on special support instruments in connection with the spread of the SARS-CoV-2 virus, Journal of Laws No. 2021 No. 737; Act of 15 July 2020 on the Polish Tourist Voucher, Journal of Laws No. 2021 No. 839; Act of 14 August

2020 amending the Act on special solutions related to preventing, counteracting and combating COVID-19, other infectious diseases and crisis situations caused by them and the Act amending the Act on special solutions related to preventing, counteracting and combating COVID-19, other infectious diseases and crisis situations caused by them and some other acts, Journal of Laws No. 1478; Act of 19 June 2020 on the solidarity allowance granted to counteract the negative effects of COVID-19, Journal of Laws No. 1068; Act of 7 October 2020 on amendments to certain acts to counteract the socio-economic effects of COVID-19, Journal of Laws No. 1747.

- ⁷ Unpublished data from ZUS Customer Service Department.
- ⁸ This is the scope of activities covered by a definition of crisis management in public administration. See Sienkiewicz-Małjurek and Krynojewski, 2010 and Walczak, 2009.
- ⁹ <http://archiwum.mc.gov.pl/projekty/plan-dzialan-ministra-cyfryzacji>
- ¹⁰ Prepared at the request of the Ministry of Digital Affairs by the research company PBS.
- ¹¹ The certificate of personal signature was included in the e-ID card, which is one of the subsequent elements of the development of e-administration (<https://www.gov.pl/web/e-dowod>).
- ¹² Unpublished data from the Department of Statistics and Actuarial Projections of the Social Insurance Institution.
- ¹³ <https://bip.zus.pl/o-zus/plany-i-sprawozdania-z-dzialalnosci-zus/sprawozdania-z-dzialalnosci-zus/archiwum?>
- ¹⁴ Unpublished data from ZUS Customer Service Department.
- ¹⁵ Such information and guidelines are published on the ZUS website and made available in the form of leaflets and brochures at customer service points in ZUS branches.
- ¹⁶ See Chapter 7 of the Social Insurance System Act, which sets out the tasks of the Social Insurance Institution (consolidated text Journal of Laws 2021 No. 423).
- ¹⁷ Unpublished data from ZUS Department of Foreign Pensions.
- ¹⁸ Unpublished data from ZUS Department of Foreign Pensions.
- ¹⁹ This term in relation to events in the area of the public sector also gives rise to interpretation controversy; in particular as a basis for taking action of a reactionary nature (see Walczak, 2009, pp. 94–98).
- ²⁰ Unpublished data of the ZUS Customer Service Department.
- ²¹ See press releases of the Economic Forum in Karpacz in 2020.
- ²² The lack of crisis management procedures in the pandemic is confirmed, inter alia, in studies drafted by consulting companies in the form of guides and knowledge bases prepared on an ongoing basis as more information about the effects of COVID-19 infections becomes available (e.g. Deloitte, 2020).

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Digital Transformation of Transportation in the Age of COVID-19

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Abstract

Purpose: To highlight the key trends in the transportation industry and the role of emerging technologies and digital transformation in acceleration of value creation. The conceptual framework suggests how such transformation could be implemented.

Design/methodology/approach: Research in a focus group was carried out where selected digital transformation frameworks were reviewed, and one was selected as the most applicable to the transportation industry. The selected framework was adopted for the transportation industry.

Findings: 1. Value creation should be positioned as the key objective of transformation. 2. Digital transformation is not so much about technology as it is about people. 3. The staged approach towards transformation allows it to be paced with account being taken of the maturity of technology as well as the maturity of competencies across the organization. For a successful digital transformation, the organization invests in development of digital capabilities. Moving towards digital means a mindset shift, cultural change and adoption of new methods of working.

Research limitations/implications: Transportation companies are at the early stage of transformation at such a scale. The case studies on successful transformations are limited. Therefore, experience is gathered mainly by the test and learn process. It is recommended that findings are validated with a wider group of experts when transformation matures. Comparing the same framework usage in other industries can also offer additional learnings to be considered by change leaders.

Originality/value: Transportation industry is in a process of transformation towards connected, electric and autonomous solutions, accelerated during the COVID-19 pandemic. The presented framework, adopted for the transportation industry, offers a practical tool for executives and change leaders to lead the transformation.

Keywords: digital transformation, transportation, leading change, connected world, electric transport, autonomous transport.

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Transformacja cyfrowa branży transportowej w dobie COVID-19

Streszczenie

Cel: wyodrębnienie kluczowych trendów w branży transportowej oraz roli przełomowych technologii i transformacji cyfrowej w tworzeniu wartości w branży. Przedstawiony model koncepcyjny transformacji cyfrowej stanowi praktyczne narzędzie, które mogą wykorzystać liderzy transformacji i agenci zmiany.

Metodologia: przeprowadzono badania z grupą fokusową, w której wzięło udział 8 ekspertów. Dokonano przeglądu wybranych modeli transformacji cyfrowej. Grupa wyselekcjonowała jeden model, który następnie został zaadaptowany do branży transportowej.

Wyniki: 1. Tworzenie wartości powinno być nadrzędnym celem transformacji. 2. O sukcesie transformacji cyfrowej decyduje nie tyle technologia, ile ludzie. 3. Etapowe podejście do transformacji pozwala nadać jej tempo z uwzględnieniem dojrzałości technologii oraz dojrzałości kompetencji w całej organizacji. Aby transformacja cyfrowa zakończyła się sukcesem, organizacja powinna inwestować w rozwój kompetencji cyfrowych. Przejście w kierunku cyfryzacji oznacza zmianę sposobu myślenia, zmianę kulturową i przyjęcie nowych metod pracy.

Ograniczenia/implikacje badawcze: firmy transportowe są na wczesnym etapie transformacji na niespotykaną dotąd skalę. Informacje dotyczące studium przypadków udanych transformacji w tym obszarze są ubogie, brakuje ugruntowanych wzorców. Dlatego doświadczenie jest gromadzone głównie w procesie testowania i uczenia się. Zaleca się, aby wyniki zostały zweryfikowane z szerszym gronem ekspertów wraz z postępem transformacji. Porównanie wykorzystania tego samego modelu w innych branżach może również dostarczyć dodatkowych informacji, użytecznych dla liderów zmiany.

Oryginalność/wartość: branża transportowa przechodzi transformację na olbrzymią skalę, dążąc do rozwiązań zintegrowanych, elektrycznych i autonomicznych. Proces ten przyspieszył podczas pandemii COVID-19. Przedstawiony model, zaadaptowany do branży transportowej, stanowi praktyczne narzędzie dla liderów zmian do przeprowadzenia tejże transformacji.

Słowa kluczowe: transformacja cyfrowa, branża transportowa, zarządzanie zmianą, transport zintegrowany, elektryczny, autonomiczny.

1. Transportation Industry and Its Challenges

The transportation industry, responsible for moving people and goods, plays an important role in economic growth. In the EU only, the transport industry directly employs around 10 million people and accounts for about 5% of GDP (EU Science Hub, n.d.).

Experts from the Volvo Group, one of the leading companies in the industry, name the following factors that create strategic as well as operational challenges for the industry: global and regional economic, regulatory, digital, technological, climate and energy resource efficiency (Volvo Group, 2020). Furthermore, the industry is shaped by shifts in customers' and consumers' behaviors and expectations, accelerated access to information, new e-commerce trends and greater adoption of digital services (Charm et al., 2020; Wang & Sarkis, 2021, p. 4).

Besides all the positive impact, transportation also contributes to noise, air-pollution and climate change. The IDTechEx Report explains

that “despite medium and heavy duty trucks representing only 9% of the global vehicle stock, large inefficient diesel truck engines combined with high average annual mileage mean that the truck sector contributes 39% of the transport sectors’ greenhouse gas emissions, which equates to about 5% of all global fossil fuel derived CO₂ emission” (Wyatt, 2020). According to analysts from the World Economic Forum, if nothing was done, by 2030, the amount of CO₂ emissions would further increase by 6 tones; in addition, the number of parcels for delivery would increase by 36%, and traffic jams would be longer by 21 minutes on average (WEF, 2020). An increasing number of environmental and safety regulations puts significant pressure on the industry to change.

The biggest challenges that remain in the transportation business are the siloed, fragmented processes, including those related to collecting, processing, and driving business value from data (BlueJay, 2019).

Satya Nadella, the CEO of Microsoft, the company that is a strategic partner to many transportation organizations, stated that “digital technology is becoming core to both how we think about resilience in business continuity, as well as bringing about that next level of productivity change and efficiencies across industries” (Business Standard, 2021).

This paper investigates the academic and practitioners’ perspective in search of the response to the following:

RQ1: What are the key trends and strategic priorities of the transportation industry?

RQ2: How has COVID-19 impacted the transportation industry?

RQ3: How to drive digital transformation in the transportation industry in acceleration of value creation?

Considering the amplified need for digitalization in the transportation industry, the paper also presents a conceptual framework for digitalization and digital transformation. The framework, based on the original concept presented by IBM, has been enhanced by the author based on the review of existing frameworks and evaluation with industry experts.

2. Key Trends and Strategic Priorities of the Transportation Industry

In 2017, the European Commission adopted the Strategic Transport Research and Innovation Agenda (European Commission, 2021), with the following strategic priorities:

- cooperative, connected, and automated transport,
- transport electrification,

- vehicle design and manufacturing,
- low-emission alternative energy for transport,
- network and traffic management systems,
- smart mobility and services,
- infrastructure.

According to the study by IBM “Truck 2030 – Digitally reinventing for the long haul” (IBM, 2011), the top trends that will influence the truck industry and the response to the above-mentioned challenges include: technology advancements, customer expectations, and the global workforce. Verhoef et al. (2021) also highlight the role of intensified competition in driving digital transformation. Heilig et al. (2017) emphasize the role of emerging technologies in increasing the productivity and efficiency they offer, as well as, with modern information technologies, provide better planning and management systems.

The leading truck manufacturers, per revenue, include Daimler, Volvo Group, Traton, Paccar.

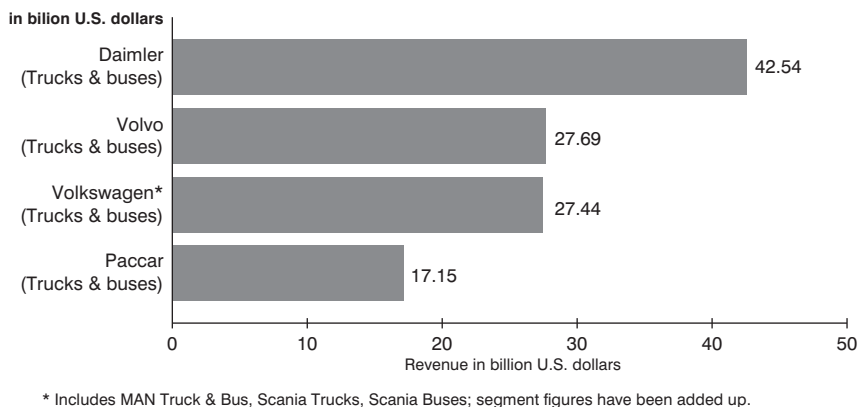


Fig. 1. Worldwide revenue of selected truck and bus manufacturers in 2020. Source: Statista, 2021.

The following analysis of the post-COVID-19 strategies of the leading providers of transportation solutions has been conducted.

	Daimler	Volvo Group	Traton SE	Paccar
Strategy pillars	<ol style="list-style-type: none"> 1. Add value for customers 2. Lead globally 3. Grow services 4. Differentiate by technologies 5. Focus on core business 6. Lean organization 7. People & culture 8. Partnerships 	<ol style="list-style-type: none"> 1. Transform the Volvo Group to become a leading end-to-end integrator as well as offering easy to integrate products and services through strong brands 2. Grow the service business 3. Accelerate electromobility solutions 4. Grow in Asia and the US 5. Develop robust profitability throughout the decentralized regional value chains 6. Selectively capture, accelerate and scale-up new businesses and develop competencies and capabilities needed 7. Reinforce value-based leadership and ways of working where all colleagues are empowered to take action and are accountable for the results 	<ol style="list-style-type: none"> 1. Brand performance — profitable growth and increased performance of our brands 2. Cooperation & synergies 3. Global expansion 4. Customer 	<ol style="list-style-type: none"> 1. Reputation for superior operational excellence and premium-quality products and services 2. Long-term growth in revenues and net income reflects increased market share in North America and Europe, excellent aftermarket parts performance and growth in financial services 3. Maintain profitability throughout the cycle due to strong cost control discipline and experienced management team
Tech driven trends	<ul style="list-style-type: none"> – Electric transport, in particular focusing on two technologies: batteries and hydrogen-powered fuel cells – Technologies assisting accident-free driving – Autonomous vehicles and supporting platforms 	<ul style="list-style-type: none"> – Autonomous, – Electric, – Connected vehicles <p>The effect will be particularly strong at the convergence of these trends as it affects vehicles, assets as well as infrastructures, and opens the way for a paradigm shift.</p>	<ul style="list-style-type: none"> – The company remains firmly committed to its pledge to invest €1 billion in electrification through 2025 – Self-driving trucks have the potential to increase the efficiency of logistics 	<ul style="list-style-type: none"> – Zero emission trucks – Battery charging solutions – Autonomous trucks – Connected services

Tab. 1. Strategic pillars and priorities of transportation industry leaders. Source: Own study, based on the companies' strategic materials and documents: Daimler, 2021b; Volvo Group, 2020; Traton, 2020; Paccar, 2021.

It can be noticed that all companies emphasize strategic pillars being customer, profitability and partnerships. The key trends are: electromobility, autonomous driving, connectivity.

3. Electromobility

Connected and autonomous vehicles (CAVs) are expected to bring important environmental, social, and economic improvements in transportation systems (Sen et al., 2020, p. 153).

Leaders in transportation focus on increasing safety and reducing the environmental footprint to increase efficiency of the whole supply chain. Electromobility (eMobility) involves deploying Information and Communication Technologies (ICT) and electric technologies in vehicles to enable electric propulsion of vehicles referred to as Electric Vehicles (EVs) (Bokolo, 2020, p. 32).

A shift towards electric vehicles requires not only a change of vehicles but also investment and development of the supporting infrastructure, for example batteries production and utilization, charging stations, traffic optimization software. Most fleets will not rely on public charging but on private infrastructure, such as at their own fleet facilities (Geotab, 2020).

Recently, the Volvo Group has launched Volvo LIGHTS, a unique collaboration between the South Coast Air Quality Management District, Volvo Trucks and 14 other organizations to pioneer a range of vehicle, charging and workforce development innovations critical for the commercial success of battery electric trucks and equipment. To facilitate electric trucks development, Daimler Trucks launched the “ePowertrain”, an architecture for all-electric trucks, where innovative and “reliable drive system components are manufactured according to globally uniform quality standards” (Daimler, 2021a).

General Motors has developed a suite of software tools to offer an EV ecosystem for the commercial marketplace. The cloud-based software platform suggests the best delivery routes and other fleet management features, location monitoring or battery status (TechCrunch, 2021).

4. Autonomous Driving

During the pandemic, consumer preferences changed as they shifted towards e-commerce. Logistics and shipping operators have been provided with a strong case to include self-driving trucks in their fleet as the means of a response to shortage of drivers or other emergencies and unforeseen circumstances (Research and Markets, 2020b). Autonomous vehicles could help to increase the delivery network capacity, reduce costs and comply with social distancing measures (Euromonitor International, 2020).

Therefore, solutions are emerging among OEMs and start-ups. Waymo, Aurora, TuSimple, Plus.ai are some such examples (Ackerman, 2021).

Scania developed Autonomous Transport Solutions, which is a complete system that encompasses handling logistics, the assignment of tasks to

vehicles, and information sharing between vehicles and infrastructure. Volvo developed the Vera autonomous tractor, which is tested to move containers from a logistics center in Gothenburg, Sweden, to the nearby port.

One example of the truck autonomous driving trend is platooning, where the human-driven truck is followed by a few autonomous trucks imitating the driving maneuvers of the lead truck (Wang & Sarkis, 2021, p. 7). The solution is powered with a set of technologies, including sensors, platooning control unit, driver controls, lidar, sonar, GPS, and radar-based collision mitigation system. Platooning remains one of the top trends in autonomous driving and companies like Daimler, Scania, Iveco, Volvo, DAF, Peloton, Huawei, TuSimple and Hyundai are testing the solutions.

5. Connectivity

Connectivity is also an enabler for automation and electromobility. By leveraging a set of technologies, data is collected and provided in real time, allowing a truck to communicate almost instantly with other vehicles and infrastructure around it. Development of Vehicle-to-Everything (V2X) is observed, which refers to Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication: “wireless technology that enables data exchange between vehicles and their surroundings” (Castellano, 2020).

Volvo Trucks claims to reduce diagnostic time by 70% and truck repair time by 25% by using IoT and artificial intelligence, which allowed for embedding telematics for over-the-air updates to engine software, and processing millions of data records instantaneously by using the on-board technology, combined with a back-end analytics platform (Violino, 2020).

Claes Erixon, Head of R&D at Scania explained: “The volume of operational data from on-road Scania vehicles is doubled every 20 months. Engineers benefit from all this information when designing new features or improving existing functions” (Bulktransporter, 2019). Another truck manufacturing giant Daimler claims their trucks are equipped with as many as 400 sensors for collecting valuable information and their software contains 100 million lines of code — more than in that of a jet plane. This data can clearly help to develop better services and enhance the performance of road freight traffic and increase its efficiency (Daimler, 2021a). Joyce Tam, PM at Peloton, stresses the lack of capabilities in data intelligence as the obstacle to the development of connectivity solutions and argues that it should remain the focus of the ecosystem (Roeth, 2019).

6. Impact of COVID-19 on the Transportation Industry

The COVID-19 pandemic, leading to social and economic lockdown, put further significant pressure on the industry. The European Automobile Manufacturers' Association (ACEA, 2021) reports that in 2020, the EU

commercial vehicle market shrank by 18.9% to reach 1.7 million units. The global truck transport market is estimated to have declined from \$1,609.2 billion in 2019 to \$1,591.8 billion in 2020, and then to recover and grow at a CAGR of 9% from 2021 and reach \$1,984.9 billion in 2023 (Research and Markets, 2020a). Near-shoring manufacturing and material sourcing grew in importance and led to the need to revamp the supply chains and goods trucking companies and how they operate (Pyzyk, 2020). At first, the industry responded to the times of uncertainty by keeping cost in check. Many vehicle factories shut down for more than 30 days (ACEA, 2021) and put their employees on furlough, reducing resources and production of vehicles. With time, it became clear that the climate change challenge and pandemic are great catalysts for the accelerated technological adoption by an order of magnitude.

The impact of the pandemic on vehicles production, on logistics and the whole supply chain prompted manufacturers to review their current business models in search of new revenue streams. As a result, transport-as-a-service (TaaS) emerges as a strong trend. It means a shift from ownership of vehicle towards a subscription model with on-demand pay-per-use solutions. As such, TaaS sits at the intersection of electromobility, autonomous vehicles and connectivity and to execute that strategy, organizations turn towards open innovation and building ecosystems, where they can play a role of a contributor, partner or an orchestrator.

During an Investors Day, Martin Lundstedt, the CEO of the Volvo Group, announced the company's focus on the TaaS, planning that, by 2030, 50% of revenue will come from those solutions and services (Volvo Group, 2021). At the end of 2020, Daimler announced the launch of Global Connectivity Services focusing on uniting the company's end-to-end digital architecture, including in-vehicle software, cloud platforms and digital solutions. It will also include work on Remote Platform Management to allow "customers to deploy and manage mobile device and mobile application solutions to fit their mixed fleet needs and seamlessly integrate those devices and apps into their trucks". It is still early to assess the long-term impact of the pandemic; however, numerous researchers investigated the impact of COVID-19 on the transportation and logistics industry and argue that the pandemic accelerated the use of digital technologies and digital transformation in the transportation sector (Medyakova et al., 2020; Almeida et al., 2020; Özispa, 2020).

7. Digital Transformation as a Catalyst of Technological Adoption

The paths of digital transformation include: digitization, digitalization and digital transformation, where the first two are considered more incremental phases towards the third one (Verhoef et al., 2020).

Oxford English Dictionary (“Digitization,” 2010) defined digitization as “the action or process of digitizing; the conversion of analogue data (esp. in later use images, video, and text) into digital form”. Digitalization (“Digitalization,” 2010), by contrast, is defined as “the adoption or increase in use of digital or computer technology by an organization, industry, country, etc.”

Digitization can be defined also as the encoding of analog information into a digital format (i.e., into zeros and ones) such that computers can store, process and transmit such information (Dougherty & Dunne, 2012, p. 1469). In other words, it is the conversion of existing data and documents into a digital format. Digitalization is the stream in which digital technologies and digitized data augment the *modus operandi* of the organization, with an impact on products, services, ways of working, thus affecting business models and value creation capabilities. It improves business processes but does not transform them. As a result of digitalization, the IT strategy is seen today “as essential to the framing of overall business strategy, that is, a fusion of IT and business strategy” (Holotiuk et al., 2017, p. 993).

Hence, while the digitization is an innovation that is centered around forward step in processes around the information such as creation, storage, transfer, etc., the digitalization centers around implementation of digital technologies also as a core element of activities that redefines lifestyle and business processes correspondingly (Ilko, 2020).

Morakanyane et al. (2017) describe digital transformation (DT) as an evolutionary process that leverages digital technologies and capabilities to enable business models, operational processes and customer experiences to create value. Verhoef et al. (2019, p. 893) describe digital transformation as a change in how a firm employs digital technologies to develop a new digital business model that helps to create and appropriate more value for the firm. Reis et al. (2018, p. 413) define digital transformation as the use of new digital technologies that enables major business improvements and influences all aspects of customers’ life. Ismail et al. (2018) define it “as the process through which companies converge multiple new digital technologies, enhanced with ubiquitous connectivity, with the intention of reaching superior performance and sustained competitive advantage, by transforming multiple business dimensions, including the business model, the customer experience (comprising digitally enabled products and services) and operations (comprising processes and decision-making), and simultaneously impacting people (including skills talent and culture) and networks (including the entire value system).”

Savić (2020, p. 28), who conducted an overview of terminological, conceptual, and historical differences between digitization, digitalization and digital transformation, points out that digital transformation leads to business transformation with new or altered business models and ways of working, providing new value producing opportunities and revenues. He

also states, based on his literature study, that “most agree [...] that digital transformation, using modern information technology (IT), represents large-scale change in fundamental business processes and components. These changes generally target business models, products, productivity, employee roles, production, marketing, financial management, and other processes. They also include cultural changes that challenge the status quo, and the way information is managed, structured, and positioned within an organization”.

In the context of transportation, digitalization can enhance transport sustainability with respect to physical, environmental, economic and social dimensions (Sarkis et al., 2020, p. 68). Thanks to the digital transformation of the entire transport sector, new business models are emerging and give rise to innovative mobility services (Tsakalidis et al., 2020). Almeida et al. (2020) suggest that “the impact of digitalization is expected to be transversal to each area and will encourage the emergence of new digital products and services based on the principle of flexibility”. Kayıkçı (2018, p. 783) points to the benefits of digitalization in transportation, such as connected processes and decentralized autonomous management, real-time full transparency from suppliers to customers, and argues that best results will be achieved when combined with the entire supply chain and not limited to the organization’s production activities. Digitalization is not only focused on cost savings, but also includes process improvements that may enhance customer experiences (Verhoef et al., 2021).

Forrester Consulting has conducted an in-depth survey on the current state of digital transformation in the global transportation industry and revealed that the three most important internal forces driving transformation, according to the respondents, include: 1) improving customer and passenger experience (65%), 2) enhancing business and IT agility (49%), and 3) improving operational efficiency (46%) (ITS International, 2021). Robin Joffe, Partner-President, Frost & Sullivan, Japan explains: “Digitalization is driving greater resource efficiencies, sparking innovation, and opening up unprecedented opportunities for growth. By upturning traditional value chains, it is encouraging stakeholders to look anew at business models, partnership strategies, and investment focus” (Frost & Sullivan, 2020).

Digital transformation is driven by implementation and adoption of technologies. At the early stage, it allows for optimization of selected processes. With the technology maturity through adapt, scale and disrupt phases, the organization can extract more value from the technology to transform the existing solutions and business models to create new value for the organization.

One such example of the journey from digitization to digital transformation can be demonstrated with cloud computing. In the increasingly digitized world, the amount of data is experiencing tremendous growth. This creates

immense opportunities for businesses to develop new products, services and business models, through data alignment and democratization. As a result, the organization can improve operational stability, resilience and performance of the data platform, expand data capacity while reducing the runtime and maintenance costs. With time, it can transform towards a data and insights driven organization. For example, telematics data captured initially to optimize the performance of an asset can be leveraged to provide 1) two-way communications capabilities; 2) situation technology (geographic attitude); 3) computing model for system rule and interface to self-propelling electronics systems (Neumann, 2018).

Vogelsang et al. (2018, p. 127) conducted research and concluded that “DT can only be successful if companies collaborate with customers, suppliers and other firms from the branch. A cultural change is necessary to enable an agile working environment as well as more interdisciplinary activities. It becomes evident that the choice of technology is essential. However, driving only technology forward is not enough to gain benefits from DT”.

8. Digital Transformation Frameworks

Issa et al. (2018, p. 974) conducted research on digital transformation in Industry 4.0 and argued that “defining one big project to realize the full potential of digital transformation in a given organization is not feasible and will definitely end in management disappointment and failure”. Hence, they developed a conceptual framework which is based on the capability maturity concept and addresses transformation through 4 levels of maturity:

Level 1 – No Industry 4.0 or only “ad-hoc”

Level 2 – Departmental level (isolated silos)

Level 3 – Organizational level (cross-departmental)

Level 4 – Inter-organizational level (cross value chain/supply chain partners).

Vial (2019, p. 127) presented a conceptual framework of DT. He describes the framework as built upon “relationships that emerged through our analysis across eight overarching building blocks describing DT as a process where digital technologies play a central role in the creation as well as the reinforcement of disruptions taking place at the society and industry levels. These disruptions trigger strategic responses from the part of organizations, which occupy a central place in DT literature. Organizations use digital technologies to alter the value creation paths they have previously relied upon to remain competitive. To that end, they must implement structural changes and overcome barriers that hinder their transformation effort. These changes lead to positive impacts for organizations as well as, in some instances, for individuals and society, although they can also be associated with undesirable outcomes”.

The importance of digital transformation resulted in leading technology and consulting companies developing the digital transformation frameworks. A selection of the most commonly used ones is presented below.

PwC built the framework “Industry 4.0: Building the digital enterprise – Industrial manufacturing key findings”, focusing on and following the stages of:

1. digitalization and integration of vertical and horizontal value chains;
2. digitalization of products and services;
3. new business models and customer access.

The transformation is powered by data and analytics as a core capability. Convergence of emerging technologies drives transformation for value creation.



Fig. 2. Digital transformation framework for Industry 4.0 by PwC. Source: *Industry 4.0: Building the digital enterprise*, 2016 Global Industry 4.0 Survey, PwC. Engineering & Construction.

Cognizant built their digital transformation framework based on four distinctive sections dedicated to Customer, Product, Processes & Systems and Organization. It highlights that digital transformation stretches beyond technology implementation and digitalizes customer experience, products and services, operations and the overall organization. It suggests that transformation cuts through the entire value chain, including partnerships.

The framework does not provide a clear guide on execution.

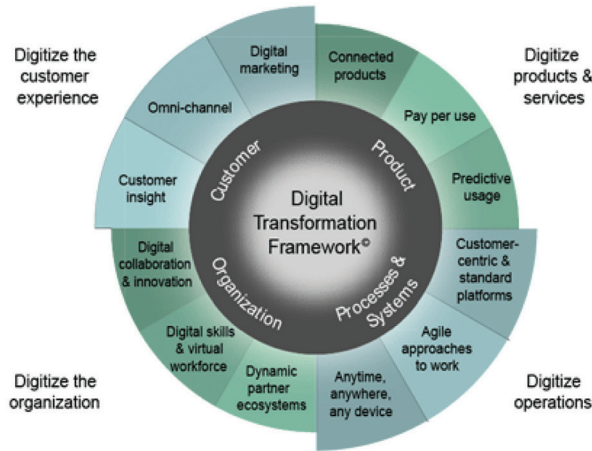


Fig. 3. Digital transformation framework by Cognizant. Source: Cognizant Services: Digital Strategy.

Boston Consulting Group’s digital transformation framework is centered around people, technology, and data. It emphasizes the importance of culture, leadership, and governance. DT is driven through phases of innovation, incubation and industrialization, where each phase includes the Outcome, Technology and Human perspective.

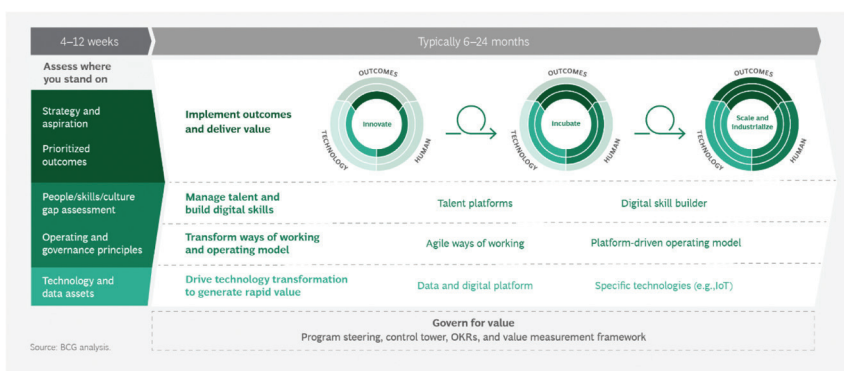


Fig. 4. BCG digital transformation framework. Source: BCG Analysis, Digital Transformation.

Accenture released its Digital Enterprise Framework in 2019. It focuses on the external perspective of customers and partners, as well as the internal perspective of employees. Digital operations cover the full cycle,

including the manufacturing and supply chain, relevant to the transportation industry. Emerging technologies are positioned as potential vehicles for transformation, while digital platforms are the enablers. Strong emphasis is also put on data.

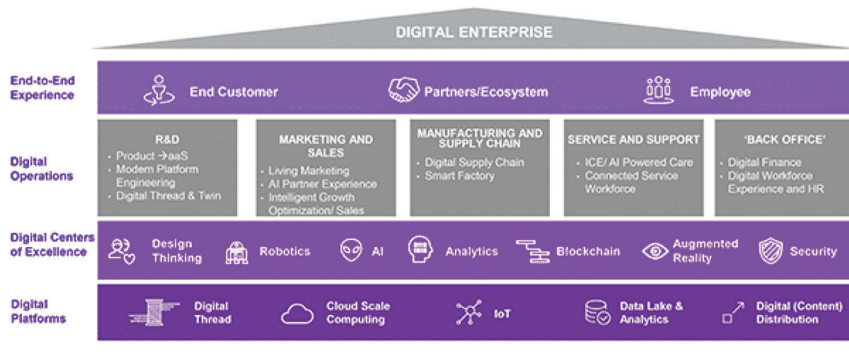


Fig. 5. Digital Enterprise Framework by Accenture. Source: Accenture.

The IBM Institute for Business Value developed a framework that focuses on the process of transformation, explained through three paths (IBM 2011).

Path 1 – Focuses on creating and integrating digital operations first.

Path 2 – Enhances, extends or reshapes the customer value with digital content.

Path 3 – Builds a new set of capabilities around the transformed value proposition.

Paths to digital transformation

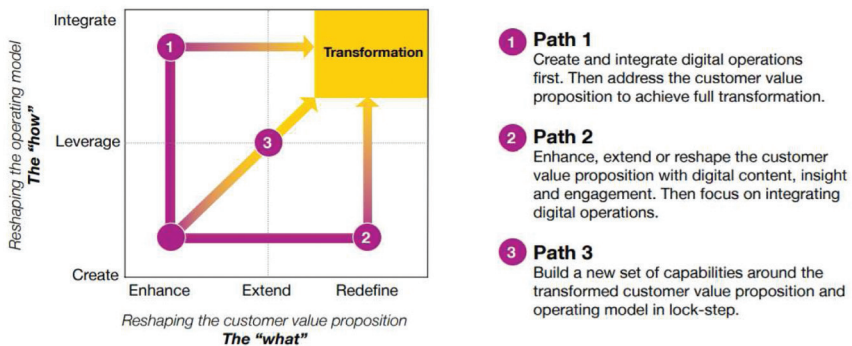


Fig. 6. Digital transformation framework by IBM. Source: IBM Institute for Business Value analysis.

9. Suggested Conceptual Framework for Digital Transformation in Transportation

Research has been done in a focus group at one of the leading transportation companies, where eight top executives, representing a mix of business, technology and support functions (i.e. HR), reviewed the selected frameworks and suggested the one that would be suitable for the transportation organization.

The discussion was guided around the following questions:

- Does it support the company strategy?
- Does it place customer at the heart?
- Is it easy to implement?

The pros and cons were captured during the discussion:

Framework	Pros	Cons
PwC	<ul style="list-style-type: none"> + It is rooted in Industry 4.0, which relates to the transportation industry + It allows to approach DT as a staged process + It positions data as a key capability + It includes emerging technologies and is up to date 	<ul style="list-style-type: none"> - Not clear where the customer is positioned - Seems to be driven from technology and not business perspective - Not intuitive to implement
Cognizant	<ul style="list-style-type: none"> + It positions customers at the heart of transformation + It takes business perspective, includes the whole organization + It is intuitive and can be applied to transportation, e.g. connected products are linked with the trend of connectivity + It emphasizes role of the ecosystem and partnerships 	<ul style="list-style-type: none"> - People and culture are not addressed - Not clear how to apply through stages of digitization, digitalization, digital transformation
BCG	<ul style="list-style-type: none"> + Focused on outcomes + Incorporates human and technology perspective + Builds on existing elements + Promotes agile ways of working 	<ul style="list-style-type: none"> - Not clear where to start and how to execute - No clear process of defining and managing priorities - Not clear how to apply through stages of digitization, digitalization, digital transformation
Accenture	<ul style="list-style-type: none"> + Suitable for transportation industry + Covers both, internal and external perspectives, positions customers at the heart + Prompts executives to ask relevant questions and lead analysis 	<ul style="list-style-type: none"> - No easy step-by-step process - No staged approach
IBM	<ul style="list-style-type: none"> + Clear directions of how to apply through stages of digitization, digitalization, digital transformation + Parallel focus on customer and business outcome + Allows for building on existing assets while creating new 	<ul style="list-style-type: none"> - No emerging technologies specified - No listed criteria and measures of success

Tab. 2. Pros and cons of digital transformation frameworks. Source: Own analyses, based on focus group discussion.

Having assessed the proposed frameworks, the experts agreed that the IBM framework allowed most flexibility for adoption by the transportation industry. It incorporated a staged approach to transformation. It also allowed for the transformation pace to be adjusted to the strategy, abilities and maturity of the organization. The following modifications were suggested, which are finally reflected in the proposed conceptual framework presented in Fig. 7.

1. The IBM framework positioned transformation at the heart of the concept. The experts argued that at the heart of every business is the value creation, hence the transformation should be closely linked to such business objective. Hence, value creation should be positioned as the key objective of transformation.
2. Further, the IBM framework suggests that transformation as a process of reshaping the operational model or changing the customer proposition. However, in practice, in complex organizations, transformation cuts across operational and value dimensions. Hence, the proposed framework incorporates three stages of digitization, digitalization and digital transformation. The experts agreed that digital transformation is not so much about technology as it is about people. This is in line with the findings of a survey conducted by Harvard Business Review, which states that “70% of all DT initiatives do not reach their goals. Of the \$1.3 trillion that was spent on DT in 2018, it was estimated that \$900 billion went to waste. Fundamentally, it’s because most digital technologies provide possibilities for efficiency gains and customer intimacy. But if people lack the right mindset to change and the current organizational practices are flawed, DT will simply magnify those flaws” (Tabrizi et al., 2019).
3. Hence, the stages of transformation should be paced with account being taken of the maturity of technology as well as the maturity of competencies across organization. For a successful digital transformation, leading to value creation, it is important that the organization invests in development of digital capabilities. Moving towards digital means a mindset shift, cultural change and adoption of new methods of working. In times of COVID-19, a prompt response to challenges required organizations to set up cross-functional task force teams that, via a collaborative approach, were able to address challenges and leverage new ways of working characterized by agility, speed and innovation (ADEPT LIVE Labs, 2020). A pragmatic approach and time to market become key drivers for developing new solutions.
4. Such transformation is led through a change management process. At the first stage, *Awareness*, employees are explained why change is required and what it means to them and to the organization. It is also when the company conducts a skills gap analysis to identify which competences must be nurtured or brought to the organization. In the next stage,

Acceptance, employees are empowered with the tools and resources enabling them to embark on change. It is a stage where employees buy-in into a process of change. Finally, with an increasing confidence towards digital they enter the *Action* stage and take ownership and responsibility for the actions. This is where the organization is ready for disruptive changes, such as launching new business models.

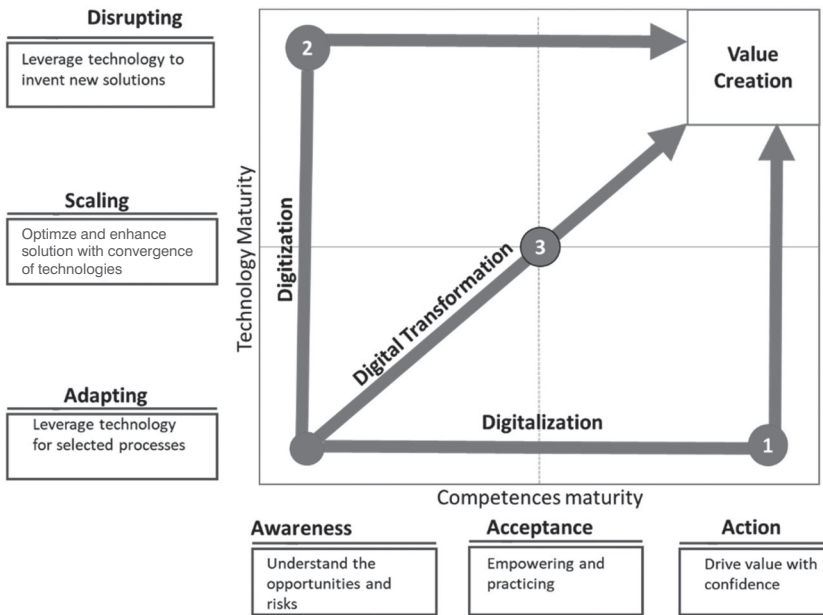


Fig. 7. Digital transformation conceptual framework. Source: Own concept, inspired by IBM Institute for Business Value analysis, IBM 2011.

For the full picture, it is also important to acknowledge the enablers of the process, such as data and selected technologies. The Strategic Transport Research and Innovation Agenda (European Commission, 2020) defines the aim of digital transformation as increasing value creation and allowing an organization to remain relevant, competitive and effective. In the context of the transportation industry, the emerging technologies can contribute to the “improved traffic flows, optimize the use of infrastructure, lower noise levels, shift greater volumes of passenger traffic towards public transport, increase the efficiency of goods transport and foster the emergence of multi-modal transport solutions”. This is where data lakes, cloud computing as well as emerging technologies like: AI, IoT, blockchain, etc. should be analyzed, and leveraged, where applicable.

Closing Remarks

COVID-19 has created the opportunities for the transportation industry to accelerate digital transformation. Some of the trends, such as new and remote ways of working, or near-shore supply demands are believed to stay and become a “new normal”. Those companies that will continue transformation by investing in new capabilities, emerging technologies and partnerships will be able to gain competitive advantage and create greater value for their customers and shareholders. For, as Steve Jobs once said, innovation distinguishes between a leader and follower.

When got right, transformation will bring benefits for the planet, people and profit, creating transportation that is safer, cleaner and more efficient.

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Virtual Learning Environments as a Remedy for Universities Against the COVID-19 Pandemic Crisis

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Abstract

Purpose: The aim of the paper is to assess the level of interest in the Virtual Learning Environment (VLE) during and before the pandemic, as well as to identify and compare solutions implemented at selected Polish universities during the COVID-19 pandemic.

Research methodology: The preliminary study was based on bibliometric analysis. The frequency of the VLE notion in the scientific literature was verified. Then a case study was applied. Six universities in Poland were analyzed, which had to make radical organizational changes in a short time, allowing them to conduct classes with students almost exclusively remotely.

Findings: The conducted analysis led to the identification of significant similarities in the procedures undertaken and organizational changes of the universities described. Some variation has been observed in terms of the software used that builds the university's VLE.

Research limitations: Only cases of universities in Poland have been described. The choice of the university was intentional.

Value: The value of the paper is to draw attention to: on the one hand, the versatility of the VLE, and on the other, certain common features that university VLEs should have in order to ensure the work of the university (and other institutions dealing with education) in a crisis situation.

Keywords: VLE, Virtual Learning Environment, COVID-19, pandemic.

JEL: I230, O320

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Wirtualne środowiska nauczania jako remedium dla uniwersytetów na kryzys pandemii COVID-19

Streszczenie

Cel: ocena poziomu zainteresowania tematyką VLE w czasie pandemii i przed nią, a także identyfikacja i porównanie rozwiązań wdrożonych na wybranych polskich uczelniach podczas pandemii COVID-19.

Metodologia badań: badanie wstępne opiera się na analizie bibliometrycznej. Zweryfikowano częstość wystąpienia tematyki VLE w literaturze o charakterze naukowym. Następnie zastosowano studium przypadku. Przeanalizowano 6 wyższych uczelni w Polsce, które w krótkim czasie musiały dokonać radykalnych zmian organizacyjnych, pozwalających na prowadzenie zajęć ze studentami prawie wyłącznie w formie zdalnej.

Wyniki: przeprowadzona analiza doprowadziła do wskazania dużych zbieżności w podjętych procedurach i zmianach organizacyjnych opisanych uczelni. Pewne różnicowanie zaobserwowano w zakresie stosowanego oprogramowania, które tworzy VLE uczelni.

Ograniczenia badawcze: opisane zostały tylko przypadki uczelni w Polsce. Dobór uczelni miał charakter celowy.

Wartość: wartością artykułu jest zwrócenie uwagi na: z jednej strony wszechstronność VLE, a z drugiej pewnych cech wspólnych, które powinny posiadać uczelniane VLE celem zapewnienia pracy uczelni (i innej instytucji zajmującej się edukacją) w sytuacji kryzysowej.

Słowa kluczowe: VLE, wirtualne środowisko nauczania, COVID-19, pandemia.

1. Introduction

Various sources indicate that the COVID-19 pandemic, resulting from the spread of the SARS-CoV-2 virus, began on November 17, 2019 in the Chinese city of Wuhan, Hubei province (Ma, 2020). The virus turned out to be so contagious that almost every corner of the globe inhabited by people was at risk of the disease. On March 11, 2020, the World Health Organization (WHO) announced a global pandemic (WHO, 2020). In Poland, the first cases of the disease were reported from March 4, 2020 (Ministerstwo Zdrowia, 2020).

The fact of an epidemiological threat forced state authorities to take radical legal steps to protect the life and health of citizens. In almost each country in the world, the way of life underwent such changes that would have been unimaginable a few weeks earlier. Total or partial sanitary restrictions were announced with varying intensity practically all over the world. According to data for April 2020, the lockdown affected more than 3.9 billion people, which was more than half of the Earth's population (Sandford, 2020). The limitations affected many spheres of peoples' life, including education, which was most often replaced by distance learning or the so-called hybrid learning. It is estimated that the governments of as many as 193 countries introduced large-scale programs to shut down entire education systems, involving about 1 billion students, the majority of whom were children (Laboure, 2021).

This paper focuses solely on universities. According to GUS data: in the 2018/19 academic year, 1.23 million people in Poland had the status of a student (GUS, 2019).

Before the pandemic, Polish universities and other educational institutions were characterized by a different level of use of e-learning and virtual learning environments (VLE). As a result, the restrictions that were introduced and the order to teach only in a remote form were not the same organizational and technological challenge for every university and educational institution.

Currently, the number of publications that deal with the issues of changes in education resulting from the pandemic is growing. Many researchers focus on the problems of changes in education from the point of view of employees or students (Rizun & Strzelecki, 2020; Klimowicz, 2020; Almarzooq, Lopes, & Kochar, 2020) or the problems of conducting research during a pandemic (Myers et al., 2020). Nevertheless, there are no studies that would attempt to analyze universities in terms of VLE built by them.

The author of this study made an attempt to fill the identified research gap. The paper compares 6 universities in Poland in terms of organizational and technological changes that these universities had to implement during the COVID-19 pandemic. The aim of this paper was to analyze these cases and find differences and similarities in the use of virtual learning environments (VLE) in the context of counteracting the COVID-19 crisis in the field of education. The main goal has been augmented with a supplementary goal. The author undertook a bibliometric analysis to determine whether the pandemic effect strengthened the interest of researchers in VLE.

2. Virtual Learning Environment (VLE)

According to the Cambridge Dictionary, the virtual learning environment is “*a system for learning and teaching using the internet and special software*” (“VLE,” n.d.). The essence of the virtual learning environment is also reflected in the definition: “*Virtual learning environment (VLE) is a system supporting the administration, organization and conduct of e-learning training with the use of tools for creating educational materials and online communication*” (Wrycza, 2010, p. 529).

Initially, VLE was understood as a synonym for LMS (Learning Management Systems) and was constructed based on the client-server architecture (Britain & Liber, 1999). The understanding of this term has changed over the years (Borawska-Kalbarczyk, 2017). Today, VLE appears to have more functionality than was predicted twenty years ago, and also uses distributed architecture and cloud computing, and sometimes even artificial intelligence technology. VLE can contain software that is one product, or it can be an integrated set of separate tools with additional functionality (Jisc, 2016). An accurate formulation, illustrating the essence

of things, is: “*the virtual learning environment is a designed information space*” (Dillenbourg, 2000).

Undoubtedly, every university in the 21st century has and develops its own VLE. But what was it like before the pandemic? In one of the papers from a dozen or so years ago, there were statements that then the implementation of VLE was only a “disruption” of teaching practices and there was no serious transformation or change in the structure of teaching and learning (Blin & Munro, 2008). This was the case in 2008, but of course, shortly thereafter, universities were ready to propose online paths for their students that took much more advantage of the benefits of VLE extended to e-learning tools.

Polish academic e-learning is subject to certain conditions (Drażek & Komorowski, 2010). And today’s virtual learning environments can be very versatile. Among other things, they can involve students in the educational process through the use of gamification elements through the use of appropriate framework (Swacha et al., 2020).

There is no doubt that the COVID-19 pandemic has triggered long-lasting changes in many sectors, including the education sector (along with higher education). Lockdown forced the adaptation of VLE to new conditions and needs. Virtual learning environments had to become flexible enough to almost completely simulate traditional classroom activities.

3. Research Methodology

In this work, in addition to the goals listed in the introduction, the following research question was posed:

Has the development of the COVID-19 coronavirus pandemic forced Polish universities to quickly expand their own virtual learning environments? – with regard to the configuration of at least several complementary information systems, dedicated to the transfer of knowledge and communication.

The purpose of the research is to answer the above question. The study was divided into two stages. The first stage is a bibliometric analysis in which the results of Google Scholar searches were used. The data covered the period from 1990 to 2020. The aim of the first stage of the study was to investigate the degree of interest the authors of scientific papers have in VLE.

The second stage of the research is a case study. Between December 2020 and February 2021, 6 universities were analyzed. The description of the research sample is presented in Table 1. The following universities were surveyed:

- the University of Warsaw (Uniwersytet Warszawski),
- the Cardinal Stefan Wyszyński University (Uniwersytet Kardynała Stefana Wyszyńskiego),

- the University of Economics in Katowice (Uniwersytet Ekonomiczny w Katowicach),
- WSB University in Poznań (Wyższa Szkoła Bankowa w Poznaniu),
- WSB Academy in Dąbrowa Górnicza (Akademia WSB w Dąbrowie Górniczej),
- the Silesian University of Technology in Gliwice (Politechnika Śląska w Gliwicach).

In order to collect the research material, information from the universities' websites was followed and statistical data from the various sources were used. Then, internal legal acts from 2020 were analyzed (rector's, dean's, chancellor's and other regulations, organizational procedures regarding safety during a pandemic and the technologies used). Next, a structured interview with employees of the above-mentioned universities and the participant observation method were used. Finally, attention was paid to the IT systems used in the context of VLE in the universities mentioned. The purpose of the structured interview was to penetrate two leading issues, namely:

- what measures have been taken to successfully continue higher education in the time of the coronavirus pandemic (legal acts, training, reconstruction of IT systems),
- what new technologies have been implemented and what technologies were used before.

In addition, during the interview, the respondents were asked how long it took them to switch to distance learning and what perturbations were related to that fact.

4. Bibliometric Analysis

A preliminary study analyzed the volume of publications and scientific studies on VLE. The analysis concerned the results of searches in Google Scholar. Three search variants were adopted:

- Variant 1. The presence of the words: “virtual,” “learning,” “environment,”
- Variant 2. The use of the phrase in the following order: “virtual learning environment,”
- Variant 3. The use of the words “virtual,” “environment” or “learning environment” in Polish-language studies.

In the first two variants, the frequency of occurrence of words and phrases in the years from 1990 to 2020 was analyzed. This time frame was adopted because most or even all publications from before the 1990s (variant 2) had to be rejected because they were wrongly cataloged by the search tool. This fact was found after a more careful analysis.

In total, the words “virtual,” “learning,” “environment” appeared about 2.6 million times, and the phrase “virtual learning environment” appeared about 65.4 thousand times. The results are shown in Figure 1. The axis on

the left shows the frequency of occurrence of any arrangement of individual words, while the axis on the right shows the frequency of occurrence of a uniform phrase “virtual learning environment.” The entire phrase appeared much less frequently, especially at the beginning of the analyzed period of time. In the last 10 years, the phrase has appeared from about 20 to 45 times less often than these words, but arranged in any order.

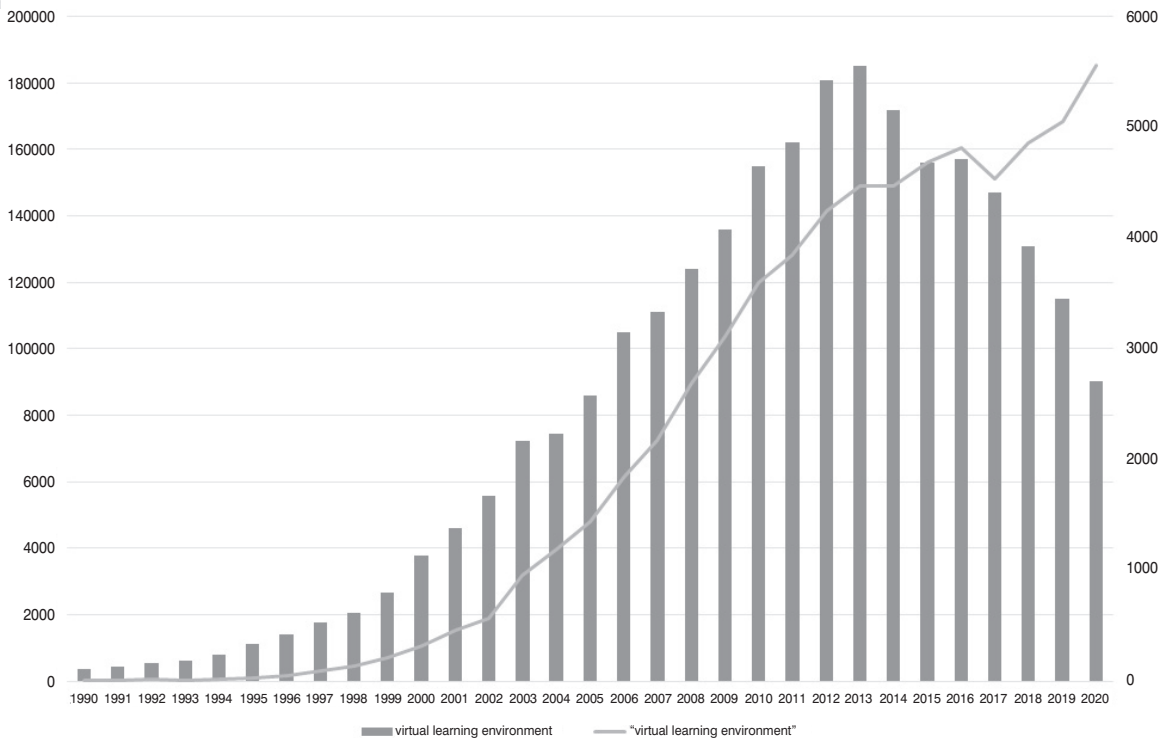


Fig. 1. The frequency of occurrence of the words: virtual, learning, environment and the phrase “virtual learning environment” in scientific articles and studies in the years 1990–2020, including citations and patents. Source: Own study based on Google Scholar data, access: 2021-06-12.

The words “virtual,” “learning,” “environment” in any order appeared most often in the years 2012–2013. From then on, a decrease in the number of occurrences was noticeable. However, the analysis of the frequency of the single phrase “virtual learning environment” is more reliable. It appeared most often in publications in the year 2020. There is a noticeable increase in the interest in this issue, despite a slight and temporary downward trend after 2016.

A similar analysis was carried out for Polish words in Polish studies (variant 3). Due to the specificity of the grammar of the Polish language, the analysis was more difficult. Ultimately, it was decided to use a query containing the phrase: “wirtualne środowisko OR środowiska nauczania.” The obtained results are presented in Figure 2.

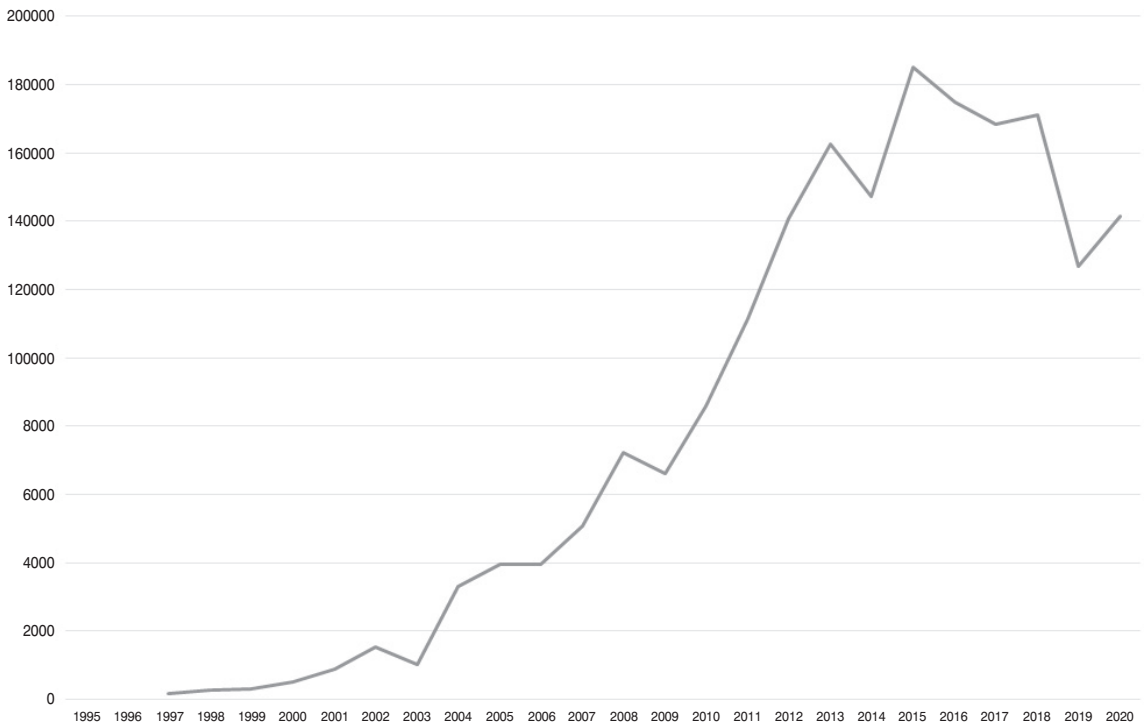


Fig. 2. The frequency of the words: virtual learning environment / learning environments in Polish-language scientific articles and studies in 1997–2020, including citations and patents. Source: Own study based on Google Scholar data, access 2021-06-12.

The number of studies in Polish on VLE is of course dramatically lower. Items from before 1997, as inadequate in content (imperfections of the method), were excluded. Looking at the chart, it is easy to see that the peak of interest was in 2015. Then a downward trend can be observed. Although there is a visible increase in the interest in 2020, this is not a very large percentage leap.

5. Case Reports

Table 1 presents descriptions of 6 analyzed cases. The universities were deliberately selected in such a way that each of them had different characteristics from the others (type of university, tradition, location, size in terms of the teaching base and number of faculties, number of students and staff).

	Uniwersytet Warszawski ^a	Uniwersytet Kardynała Stefana Wyszyńskiego ^b	Uniwersytet Ekonomiczny w Katowicach ^c	Wyższa Szkoła Bankowa w Poznaniu ^d	Akademia WSB w Dąbrowie Górniczej ^e	Politechnika Śląska w Gliwicach ^f
Type of university	public	public	public	non-public	non-public	non-public
Location	Masovian Voivodeship	Masovian Voivodeship	Silesian Voivodeship	Greater Poland, Silesia and West Pomeranian Voivodeships	Silesian and Lesser Poland Voivodeships	Silesian Voivodeship
Tradition	Since 1886 (204 years)	Since 1954 (46 years)	Since 1936 (64 years)	Since 1994 (26 years)	Since 1995 (25 years)	Since 1945 (75 years)
Number of campuses, buildings in use of the university	3 campuses, 184 buildings	2 campuses, 23 buildings	2 campuses, 11 buildings	3 campuses, each in a different city	5 campuses, each in a different city	3 campuses
Number of faculties (colleges)	24	12	4	3	5	15 (including 2 institutes)
Number of employees ^g	about 7000	about 1250	about 1450	about 400	about 350	about 3200
Number of students ^{h,i}	40.6 K	9.3 K	8.1 K	17 K	7.5 K	18.1 K

^a Based on: <https://www.uw.edu.pl/uniwersytet/fakty-i-liczby/>, access: 2021-01-28.

^b Based on: <https://uksw.edu.pl/pl/uniwersytet/uczelnia-dzis>, access: 2021-01-28.

^c Based on: <https://www.ue.katowice.pl/uczelnia/o-uczelni.html>, access: 2021-01-28.

^d Based on: <https://www.wsb.pl/poznan/poznaj-wsb/o-uczelni>, access: 2021-01-28.

^e Based on: <https://wsb.edu.pl/o-uczelni--misja-status,m,mg,1>, access: 2021-01-28.

^f Based on: <https://www.polsl.pl/Informacje/Uczelnia/Strozy/witamy.aspx>, access: 2021-01-28.

^g Based on Bisnode, <https://www.bisnode.pl>, access: 2021-02-14.

^h Data for 2019, based on (GUS, 2020, pp. 40–45).

ⁱ Data for 2018/2019, based on (GUS, 2019).

Tab. 1. Description of the analyzed cases of universities in Poland. Source: Own study based on the given sources and interviews.

The method of analysis (case study) proposed later in the paper is of a qualitative nature. It does not answer the question whether all universities in Poland coped with the crisis, but indicates how those universities that were selected in the study handled the difficulties in a deliberate manner.

6. Cases Comparison

The universities had to implement specific organizational solutions that allowed for the replacement of traditional education with the remote mode. These solutions had to be in line with overriding state legal acts that applied to all universities. This paper only deals with the internal regulations and procedures that have been implemented. It was these regulations that had a significant impact on the way education programs were (and continue to be) conducted and on what software was approved for the use within the university. It is this software that has become the building block of the university VLE.

Each of the universities implemented ordinances at the rector's and dean's level, regulating the principles of conducting classes during the pandemic. Administrative matters were usually regulated by chancellor's regulations. Moreover, procedures adequate to the degree of epidemiological threat were adopted. Another important issue was to initiate training for the staff.

In each university, training courses were conducted that concerned the technical aspects of software use and important aspects of teaching methodology. Each of the universities had implemented e-learning before (usually for several years), so a significant part of the staff did not need to learn from scratch. Hence, many trainings were not only designed to teach the basics of the service, but were advanced in nature, extending the already possessed competences.

In addition, each university formally regulated which IT tools would be allowed for remote classes. Since such elements of VLE as the student service system or e-learning platform had long been used in each of the universities, it was more related to the VLE complementary software. Almost every university had taken the first steps toward the implementation of e-learning, the first installations of the e-learning platform, staff training over a dozen or even about 20 years before the outbreak of the pandemic.

Table 2 compares the described cases in terms of the introduced organizational changes and specific activities, training, and technologies used. Large convergences were observed in the procedures and organizational changes undertaken, as well as in the training sphere of the universities described. Therefore, they were described uniformly for all universities in Table 2, without listing specific internal legal acts. The table also compares selected software packages used during the pandemic.

	Uniwersytet Warszawski	Uniwersytet Kardynała Stefana Wyszyńskiego	Uniwersytet Ekonomiczny w Katowicach	Wyższa Szkoła Bankowa w Poznaniu	Akademia WSB w Dąbrowie Górniczej	Politechnika Śląska w Gliwicach
Regulations and procedures	Regulations at the rector's level, at the dean's and chancellor's levels. Necessary sanitary and safety procedures were implemented as well.					
Training	Methodological, technical and maintenance training – varied levels of advancement					
The tradition of e-learning implementing	>10 years					
E-learning platform	Moodle (Campus, eNauka)	Moodle (eUKSW)	Moodle	Moodle	Moodle (OnlineWSB)	Moodle
Student service system	USOS ^a	USOS	Simple.Bazus	Intranet/ Extranet (dedicated software)	e-UNI	USOS
The dominant tool for synchronous communication	ZOOM	Microsoft Teams	Google Meet	Microsoft Teams	Clickmeeting – recommended, but also acceptable: Zoom, Microsoft Teams, Google Hangouts and other ^b	Zoom
Virtual desktops	VDI – IBM VMware Horizon	Yes, but mostly used for remote work	VDI – IBM VMware Horizon	Virtual Box – rather locally	Yes, but no specific data is available	VDI – IBM VMware Horizon
Cloud computing services	Microsoft 365					

^a USOS, <https://www.usos.edu.pl/> access: 2021-02-11.

^b Based on: <https://wsb.edu.pl/index.php?p=m&idg=KORO,5390>, access: 2021-02-15.

Tab. 2. Selected aspects of case studies in terms of selected organizational and technological changes of the VLE in connection with the COVID-19 pandemic. Source: Own study.

Table 2 shows the synthesis of research based on a legal analysis, interviews and participant observation. This table indicates that there were many similarities in the activities of the universities. The university authorities approached internal legislative acts or training of teaching staff in a similar way. Each of the universities has quite a long tradition of implementing e-learning (always longer than 10 years). On the other hand, the differences occur mainly in the field of selecting the elements of the university's VLE.

Some elements of VLE are consistently used by all the universities surveyed. Thus, all universities use the Moodle e-learning platform and Office 365 as a cloud computing solution. There are differences in the selection of the student service system. USOS is popular with, but not all, public universities. Moreover, apart from USOS, dedicated systems are also used. Among the tools for synchronous communication, Microsoft Teams and Zoom are most often employed in teaching. Other systems were also used. The most popular virtual desktop tool is VDI – IBM VMware Horizon. Still, it was also not the only possible option here. The selection of VLE elements could result from a certain consequence of using previously selected solutions or the choice between popular and recommended systems.

As a result of the fact that universities already had extensive VLEs, it was very quickly possible – considering the crisis conditions – to propose an alternative, remote mode of education. It was the fact of having a comprehensive VLE that helped ensure that the transition period to e-learning did not exceed two weeks. Such a time period or less was given in the interviews. At the same time, some universities allowed, in the summer semester of 2020, that classes should be mainly asynchronous, but already in the winter semester of 2020/2021, classes could be held fully synchronously. Existing VLEs were only enriched with instant messaging or cloud services, and virtual desktops became more commonly used outside university walls.

7. Research Limitations

The bibliometric analysis concerned the 1st and 2nd variants of the phrases in the English language. Option 3 concerned Polish words. Since the results of Google Scholar searches were used, which process huge amounts of data, all the advantages and disadvantages of such methods should be taken into account. Inaccuracies may result, among others, from incorrect tagging and cataloging of some publications (which has already been mentioned in the context of pre-1990 and Polish works before 1997).

The correction for ambiguity in the interpretation of the term VLE should also be taken into account, especially in the earlier literature. The frequency of the abbreviation VLE was not analyzed as it also has other connotations.

The described case studies concern only Polish universities. The selected sample was purposeful and aimed at presenting good practices. The author's observations show that many Polish universities have followed a similar path.

8. Discussion

The bibliometric analysis showed a certain increase in the interest in VLE in 2020. However, it should be noted that this was not a dramatic increase. This means that the subject of VLE turned out to be interesting for many

authors many years before the pandemic. Thus the interest had been around for a long time before and the pandemic effect only strengthened it slightly.

Due to the fact that VLE had already been operated by universities, it was possible to find a solution to the existing difficult situation in a relatively short time. If, however, universities had not been interested in e-learning and building VLE before the pandemic, the need to start distance learning and hybrid learning would have faced powerful barriers of various nature (lack of technology, lack of staff competences, organizational chaos). The analysis of the described cases shows that the previous experiences with remote teaching in the case of each of the universities enabled them to organize substitute education based on the technology and competences of the academic staff relatively quickly.

The described implementations, solutions, and tools are likely to continue to be used, even after the pandemic has ended. On the other hand, various internal laws that have been enacted at these universities are likely to be temporary and will expire or be repealed after the pandemic ends.

Unfortunately, not all educational institutions coped with the crisis as efficiently as the universities described above. The report “Remote education during the pandemic” concerns primary and upper secondary schools (Buchner & Wierzbicka, 2020). The report reveals a long list of problems faced by schools. These included low digital competences of teachers, chaos, disinformation, negligible support from the Ministry of National Education, a mismatched core curriculum, insufficient preparation not only for the first, but even for the second wave of the pandemic. All this had an impact on the psychological well-being of teachers and students. As a result, it could translate into total passivity and exclusion, which results in the so-called “disappearing” teacher and “disappearing” student. The author’s private observations show that some educational institutions only adopted communication platforms for their purposes after the summer holidays and managed to train their teachers. This clearly shows how beneficial it was to create comprehensive virtual learning environments for universities before the pandemic. The availability of virtual learning environments significantly facilitated the adaptation of universities to crisis conditions.

9. Conclusions

The analyses made allowed for the formulation of the following conclusions:

1. The results obtained in the bibliometric study show that VLE has been of interest to various types of researchers for many years. The shapes of the curves in Figures 1 and 2 are quite similar to popular product life curves. However, in 2020 the effect of interest in VLE was strengthened. The increase in interest, however, was not dramatic.

2. Universities had been building their own VLE for a long time. The pandemic effect accelerated certain decisions and certain – ongoing – processes. The internal legal acts that came into force in the analyzed universities were quite similar in nature. The main differences concerned the IT tools adapted to the needs of universities.
3. These universities had been implementing e-learning for a good dozen or so years (or more), with the main emphasis being on asynchronous communication and the use of the e-learning platform for this purpose.
4. All of the analyzed universities were equipped with e-learning platforms before the pandemic. In each case, it was the Australian open source e-learning platform Moodle¹, which is available under an open license. This platform is particularly popular in this part of Europe and readily adopted and used by universities in Poland. Thus, universities, in many cases, were much better technologically prepared for the crisis than secondary and primary schools in Poland.
5. The outbreak of the pandemic and sanitary restrictions forced the use of alternative IT tools for videoconferencing. Each of the universities had to quickly add such a system to the package of its IT systems necessary for efficient teaching processes. The identified software is Zoom, Microsoft Teams, and Google Meetings.
6. The interest in cloud computing services has increased, which mainly refers to the Microsoft 365 service (formerly Office 365).
7. Remote desktop services have become widely used outside of the classroom.
8. While in the summer semester of 2020 it was acceptable to use only asynchronous communication tools, from the winter semester 2020/2021 practically every school forced the use of real-time communication tools as well.
9. If universities had not implemented e-learning earlier, the effects of the lockdown would have been more severe for them. Thanks to such implementations, it was possible to ensure a relatively small delay (not longer than 2 weeks) for the educational service.

The conducted research allows for a positive answer to the research question. Hence, the fact is that the COVID-19 pandemic and the lockdown made Polish universities expand their own VLE. Previously, these VLEs were a configuration of at least several complementary IT systems, dedicated to the management of the teaching process, knowledge transfer and communication. Most VLE builders had been used before. In the report by M. Klimowicz, the author indicated 5 phases of distance learning in the COVID-19 era (Klimowicz, 2020). Phase one: suspension and chaos were unavoidable, but there are indications that VLE mitigated this effect.

There is much speculation about what will remain from the adopted solutions in education after the pandemic. Perhaps, long-term changes in the methods that countries use to provide education to their citizens and

the globalization of the education market, which will benefit the most elite schools, are to be expected. And this will come at the expense of lesser-known schools (Laboure, 2021). In the author's opinion, the quality of university's VLE can be an important competitive advantage.

Moving on to the summary of the work: the observations and analyses made clearly indicate that without prior orientation to modern educational technologies and appropriate steps toward educational innovation, universities in Poland would have been much more severely affected by the effects of the pandemic and lockdown. We operate in a global economy, which is increasingly exposed to global problems. The experience of resisting the pandemic crisis by universities in Poland also shows how important expenditure on research and development of new technologies (including educational technologies) is in the modern economy.

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Endnotes

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Cloud Communications During the Pandemic From the Perspective of Collaboration Platforms

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Abstract

Purpose: The aim of this research is focused on the identification of communication patterns prior and after COVID-19 was announced and the approach to the choices that end users make in various aspects of life.

Design/methodology/approach: The authors decided to execute two-step research including practical use of 4 popular collaboration platforms: Microsoft Teams, Zoom, Jitsi, Google Meet, based on the proved user experience. After a defined focus group of respondents gathered hands-on experience in a controlled manner, using the defined communication platforms, further research was carried out in the form of a survey to assess the change of behavior of respondents, considering IT tools used to support distance learning and collaboration. The research included a comparison of behavior prior the epidemic and during the epidemic period. The research covered the following aspects: how the behavior patterns of UCC use have changed across the identified areas (business, educational, private) and what are the most preferred toolsets. The following structure was applied: a short introduction to the communication platforms, definition of the research method, analysis, and discussion of the identified results.

Findings: The conducted survey identified the following elements: the level of digital communication among respondents and the familiarity with different platforms have a significant role in the use and development of UCC platforms. The generic conclusion of the research was that almost all respondents have prior experience using UCC platforms. The survey has proved the 100% use of UCC cross various areas of life. Based on the research, it has been noticed that respondents tend to use one or two UCC platforms as a standard for business and private use. UCC platforms that are more widely used across

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different areas of life are rated as the most preferred by the respondents and include Microsoft Teams (30%) and Google Meet (23%).

Research limitations/implications: The usage of non-probabilistic sampling, a relatively small sample and the usage of qualitative analysis methods were major limitations of the conducted research. Firstly, the research data was collected from students of one specialty, from one specific university. The research did not find any cultural differences in distance learning and communication. Secondly, the study uses basic statistical measures without cross analysis to enable a deeper analysis of the research.

Originality/value: The presented paper is a part of the research area related to communication platforms across various areas of peoples' life. The research was aimed at the identification of the most preferable UCC platforms and features that serve the communication purpose. The cognitive value of the paper might also be seen in the focus on a relatively narrow and homogenous group of respondents (students of e-business and digital marketing).

Keywords: user experience, Unified Communication and Collaboration (UCC), collaboration platforms.

JEL: M15, O32

Współpraca w chmurze w pandemii z perspektywy wykorzystania platform komunikacyjnych

Streszczenie

Cel: identyfikacja wzorców komunikacji przed i po ogłoszeniu COVID-19 oraz podejścia użytkowników końcowych do wyboru platform komunikacyjnych wykorzystywanych w różnych aspektach życia.

Projekt/metodologia/podejście: autorzy postanowili przeprowadzić dwuetapowe badanie, obejmujące praktyczne wykorzystanie 4 popularnych platform komunikacyjnych: Microsoft Teams, Zoom, Jitsi, Google Meet, oparte na zweryfikowanym doświadczeniu użytkowników. Po wspólnym wykorzystaniu przez grupę studentów na zajęciach zdefiniowanych platform komunikacyjnych przeprowadzono dalsze badania w formie ankiety, mającej na celu ocenę zmiany zachowań respondentów, z uwzględnieniem narzędzi informatycznych wykorzystywanych do nauki na odległość, komunikacji i współpracy. Badania obejmowały porównanie zachowań przed ogłoszeniem epidemii oraz w początkowym okresie epidemii oraz następujące aspekty: zmiana wzorców zachowań, związana z korzystaniem UCC w zidentyfikowanych obszarach (biznesowym, edukacyjnym, prywatnym) oraz identyfikację najbardziej preferowanych platform komunikacyjnych lub narzędzi wspierających komunikację. Zastosowano następującą strukturę: krótkie wprowadzenie do koncepcji platform komunikacyjnych, określenie metody badawczej, analiza i omówienie zidentyfikowanych wyników.

Wnioski: w przeprowadzonym badaniu zidentyfikowano następujące elementy: poziom komunikacji cyfrowej wśród respondentów oraz znajomość różnych platform odgrywają istotną rolę w wykorzystaniu i preferencjach platform UCC. Ogólny wniosek z badania był taki, że prawie wszyscy respondenci mają wcześniejsze doświadczenie w korzystaniu z platform UCC. Badanie wykazało, że podejście wskazuje 100% wykorzystanie UCC w różnych dziedzinach życia. Na podstawie przeprowadzonych badań zauważono, że respondenci zwykle używają standardowo jedną lub dwie platformy UCC w przypadku wykorzystania biznesowego i prywatnego. Platformy UCC, które są częściej wykorzystywane w różnych dziedzinach życia są oceniane jako najbardziej preferowane przez respondentów i są nimi Microsoft Teams (30%) i Google Meet (23%).

Ograniczenia/implikacje badawcze: głównymi ograniczeniami prowadzonych badań było wykorzystanie próby nieprobabilistycznej, stosunkowo małej próby oraz wykorzystanie metod analizy jakościowej. Po pierwsze, dane badawcze zostały zebrane od studentów jednej specjalności i z jednej konkretnej uczelni. Badania nie wykazały różnic kulturowych w nauczaniu na odległość i komunikacji. Po drugie, badanie wykorzystuje podstawowe miary statystyczne bez analizy krzyżowej, w celu przeprowadzenia głębszej analizy.

Oryginalność/wartość: prezentowany artykuł wpisuje się w obszar badawczy związany z platformami komunikacyjnymi w różnych obszarach życia. Badanie miało na celu identyfikację preferowanych platform UCC oraz funkcjonalności najwyżej ocenianych jako przydatne do celów komunikacyjnych. Wartość poznawczą artykułu można dostrzec także w odniesieniu do stosunkowo jednorodnej grupy respondentów (studentów kierunków e-biznesu i marketingu cyfrowego).

Słowa kluczowe: doświadczenie użytkownika UX, komunikacja zintegrowana UCC, platformy komunikacyjne.

1. Introduction

The emerging change of human life caused by the global announcement of the COVID-19 pandemic era had a significant impact on business, personal life and education. Rapidly, every aspect of life went to the internet including: remote work, virtual meetings with friends, family and co-workers via various communication platforms, health care in the form of tele (remote) consultancy, and online teaching. Each aspect of life was affected by extended lockdowns, social distancing and global recommendations to “stay at home” forced by national regulators and even penalized in case of breaking the social distancing order. Various research on global levels indicated that nearly two-thirds of educational institutions had planned in-person instruction for the second semester 2020 (Quintana, 2020); similarly, businesses have turned to remote work (PricewaterhouseCoopers, 2021; Global Workplace Analytics, 2020; European Commission, 2020; Gartner, 2020).

This situation has spurred even more dynamic development and improvement of available communication platforms that isolated people might benefit from for various purposes. The new reality means that the direct contact and collaboration is not possible anymore and only electronic communication channels could enable any form of communication between people. The very concept to collaborate remotely has been known for a longer while, where initial attempts at such methods of collaboration in an extended form started in the late 90s and at the beginning the 2000s, when the internet started offering a global network also using the first commonly available communication platforms, known as unified messaging applications. Those platforms were limited by technology only to providing users with non-real-time communication data such as: email, faxes and voice mail across the devices (Burns et al., 2001; Fikry & Mukhtar, 2012; Meske et al., 2018), with further development of such technology called later as Unified Communication and Collaboration (UCC). The concept of UCC rapidly developed, in line with the popularity of the internet, evolving available communication tools to very sophisticated collaboration platforms currently known as cloud-based web conferencing technology. The idea behind the UCC is to ensure interaction between teams, and no matter where you work, you can still access the same secure system, equipped

with at least: messaging, voice and video calling, team collaboration, video conferencing and file sharing (Riemer & Taing, 2009).

2. Literature Review

The area of distance learning and accompanied research is quite reach. Moving the whole area to the remote reality has accelerated defining a new perspective of use of different communication supporting tools and solutions despite the definition of such platforms has been documented well. The authors follow the definition of UCC provided by the Businesswire where “UCC or unified communication and collaboration is the service which delivers multiple communication methods. Such as Business phone system, Voicemail, Instant message, Chat, Fax, Conference call bridge, Video conferencing, IVR and more. Unified communication and collaboration is also capable of integrating e-mail, web applications, social media, and business tools on cloud. Seamless connection of global business locations alongside enabling effective team-collaboration are crucial benefits of UCC tools for organizations. For this reason, UCC is the backbone of team collaboration.

UCC is composed of many benefits such as improved work quality, faster services, enhanced employee flexibility, reduced expenditure, etc. On the basis of services, UCC is categorized into three services: UCaaS, CCaaS, and CPaaS. Unified Communications as a Service (UCaaS) is responsible for cloud based delivery of voice chats, emails, chats, etc. It can be either subscribed or free. Whereas, Contact Center as a Service (CCaaS) offer customer service solutions and Communications Platform as a Service (CPaaS) provide API's and software tools for developers to add real-time cloud” (Businesswire, 2020).

During the global lockdown due to the COVID-19 pandemic, the adoption of UCC and remote video technologies to support remote learning became widespread as virtual communication techniques to facilitate real-time conversation between different end users (Okerefor & Manny, 2020).

The latest research provided by Businesswire in the Global Unified-Communications and Collaboration Industry report (Research and Markets, 2020; Businesswire, 2021) indicates that the COVID-19 crisis is acting as a major accelerator for the UCC market. The market is witnessing a spike in usage of various UCC tools such as Zoom and Microsoft Teams, Google Meet, Slack and other free-of-charge tools. All those are becoming the most important for enterprises and educational institutions for achieving effective communication and collaboration. Initial pre-pandemic worth of the global market for Unified Communications and Collaboration was initially estimated at US\$33.5 billion in the year 2020, and currently is projected to reach a revised size of US\$52.9 billion by 2027, growing at a rate of 6.7% over the analysis period 2020–2027.

Coming further in line with the Gartner report, it is forecasted that, by 2024, in-person meetings will account for just 25% of enterprise meetings, down from 60% before the pandemic, driven by remote work and changing workforce demographics. The forecast is in line with the observation of the authors presented in the first part of this research in 2020, where the authors identified 3 areas of use of UCC where changes in frequency were already noticed during the first quarter of the pandemic era: “The percentage of respondents that have declared the use of UC platforms for professional purposes during working days increased from 69% to 88%. [...] the increase of use of such platforms respectively 50% (23% increase) for work days and 96% (34% increase during weekends) to serve learning needs [...] The percentage of respondents that have declared the use of UC platforms for private purposes, after the lockdown was announced it has been noticed increase of 15%” so the change of behavior towards UCC is already visible and to be monitored and measured at later stages.

3. Methodology

The observation of a new reality and challenges with between-people communication and collaboration using digital media has encouraged the authors to carry out an experiment with the use of chosen UCC with various student groups. The aim of the experiment was to move the learning experience from in-person to online reality, involving students and speakers in defining the UCC that fits the purpose from the perspective of various end user needs, with a particular focus on online meeting applications that are easy to implement and have a rich set of features. It allowed the assessment, based on proved user experience, of what tools are identified by students as the most suitable to provide and receive remote lectures and tutorials as well as to be used for private communication and collaboration.

The method employed for this research was fully online teaching for various types of students of the Faculty of Management, University of Warsaw with a moderate class size of 25 people. The two-step research included practical use of 4 popular collaboration platforms: Microsoft Teams, Zoom, Jitsi, Google Meet. After the group of students jointly used the defined communication platforms, further research was carried out in the form of a survey to assess the most suitable communication platforms. A survey was done at the end of the semester to probe how the students felt about the proposed UCCs and their usefulness for various types of learning. The research covered the following aspects of the user experience: ease of use, provided functionality and work comfort.

The authors analyzed communication and collaboration aspects using different cloud-based platforms across target student groups. The aim of the research was to identify the change in frequency of use as well as suitability of various UCCs based on the type of communication and collaboration, thus

three types of usage were defined as the baseline of this research: business, educational and private. The authors decided to execute the research within the focus group coming from the 2020 award winning E-Business and Digital Marketing in Eastern Europe studies (Eduniversal Group, 2020) to enable the best possible understanding and perception of the researched aspects. The approach taken consisted of several steps that allowed for collecting realistic data based on validated user experience related to hands-on practice in using the identified communication platforms. The authors decided to take this approach to mitigate the research limitations related to the number of respondents, at the same time engaging in the research the whole group of students of the mentioned e-business specialization. The total number of final-year students during academic year 2019/2020 in the assessed specialization counts 39 individuals. The identification of the respondent group was not accidental, the authors took the convenience sample approach, benefiting from the profile of e-business students seen as the most advanced users and practitioners in IT.

This article is complementary to the authors' article from 2020 that was focused on the enrichment of educational experience through the use of collaborative platforms. Due to a different scope of analysis, a similar database was analyzed to achieve additional or extended conclusions. The composition of 34 research questions allowed the authors to formulate the conclusions on the following two research questions:

- Q1. How have the behavior patterns of UCC use changed across the identified areas (business, educational, private)?
- Q2. What are the most popular UCC platforms across the tested group of end users?

The group of students that participated in the research had previous experience with platforms other than those analyzed so it allowed a subjective assessment of the analyzed platform on top of other well-known and used UCCs.

The authors have used following approach to the research:

- theoretical research in the area of UCC used in online learning,
- definition of elements under research to support suitability for cloud communication use,
- identification of features to support communication and collaboration,
- preparation of an online survey,
- hands-on experience of installing and configuring the indicated communication platforms,
- deployment of the online version of the survey on the target survey platform sited on the Faculty of Management of the University of Warsaw native permits/servers,
- verification of the survey and its functionality by the focus group of end users,
- distribution of an active link to the survey and setting up the time window for the research,

- collection of survey data using a questionnaire hosted on the online survey platform, analysis and discussion of results,
- conclusion from the results obtained from the survey.

The questionnaire comprises a number of ratings and scales, represented online via individual or matrix style layouts including: radio buttons, drop-down menus, rating lists or free text entry.

The report utilizes the data from the survey conducted in May 2020. There were a total of 43 answers, from which 26 were fully answered, and thus are the baseline of the analysis presented in this paper. All the respondents who took part in the experiment had previous experience with various communication platforms and as least a basic level of experience with the 4 targeted platforms.

All respondents declared full-time employment, so it was assumed that the majority of students had to use communication platforms within all three areas of use: professional, educational and private.

The most frequent age of the respondent was in the range 24–25 (42% of all respondents). The average age of 27 years indicates the age of typical students of the second cycle (the first cycle has been completed). Gender distribution of respondents is as follows: 65% of male and 35% of female respondents. Distribution of place of living: cities with over 100,000 residents – almost 46%, towns/cities with 10,000–100,000 residents – 35%, 19% from rural areas and towns up to 10,000.

In order to analyze the change in the use of UCC tools, questions were formulated concerning the periods before and during the initial COVID-19 pandemic:

- December 2019 – February 2020 (3 months before the start of the epidemic in Poland),
- March 2020 – May 2020 (from the moment when remote work was recommended by the government / employer / client / educational sector).

The research was designed in such a way as to investigate initially the frequency of use of UCC tools and platforms and then to make the assessment of particular features and conditions that affect wider and more often use of the analyzed platforms.

This paper is focused only on chosen aspects of spanned research and remaining data will be used in complementary papers. The reader should also bear in mind that the question wording and practical difficulties in conducting surveys can introduce error or bias into the findings of opinion polls.

4. Results

The authors analyzed the most favorite UCCs from the perspective of the surveyed respondents. Apart from the defined 4 platforms, respondents where requested to provide information about additionally used tools (Figure 1).

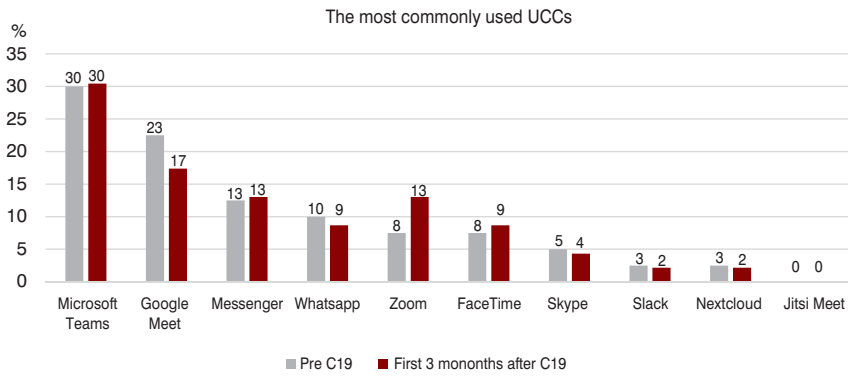


Fig. 1. The most preferable UCC platforms (pre-COVID-19, first 3 months after COVID-19). Source: Own work.

Considering the confidence in the use of such platforms and subjective choice of respondents, Microsoft Teams is rated the highest, with 30% of respondents choosing this platform, the next rate with the result of 23% is given to Google Meet, and the next place is taken by FB Messenger. This rating might suggest that social media are seen as an important channel for communication and collaboration by young adults.

Analyzing the pre-COVID-19 period and the first 3 months of COVID-19, it is noticed that the Microsoft Teams platform is seen as the most convenient and popular communication and collaboration channel. Also Google Meet seems to be as popular as prior to COVID-19. A small change is seen in the rating at the third position, where Zoom has got a higher rate with the same share as Messenger (13%), whereas the remaining applications remain at the same positions.

To identify the change in the UCC pattern, the authors analyzed both the level of digital communication among respondents and their familiarity with different platforms.

The initial finding indicates that only 1 respondent was not using UCC for any of 3 given reasons prior to the COVID-19 period, yet the pandemic reality changed that and 100% of respondents indicated that UCC is currently used either for business, educational or private communication.

Based on the feedback received, the authors collected data on the number of UCCs used for the defined purposes (Figure 2).

Pre-COVID-19					
No. of UCCs used	0	1	2	3	>=4
Professional	19%	38%	27%	12%	4%
Educational	27%	15%	8%	8%	42%
Private	15%	54%	23%	8%	0
First 3 months after COVID-19					
No. of UCCs used	0	1	2	3	>=4
Professional	12%	38%	46%	0	4%
Educational	0	4%	4%	12%	81%
Private	8%	50%	12%	23%	8%

Fig. 2. Number of UCC used for business, education and private connectivity (pre-COVID-19, the first 3 months after COVID-19). Source: Own work.

Looking at the statistics, all respondents indicated that in majority, they used 1 or 2 UCCs both for business and private purposes while for educational needs, they indicated 4 or more platforms used. The might highlight the diversity of available UCCs within the educational area that are chosen by providers of training, lecturers, providers of workshops to meet particular needs. This also highlights the lack of a unified approach across educational institutions. Such an approach, despite expanding students experience with various tools, platforms and interfaces, might also assume a lack of user confidence caused by the need for continuously testing new and unknown tools. And on the other hand, this might indicate that educational institutions will not create a global trend as regards the used communication channels and platforms and that the rate of faults might be higher due to limited and isolated testing of the population as well as a lower level of adaptability to end users' needs.

On the other hand, a high rate of single UCC use for business and private needs might indicate that respondents chose one but well-known communication platform rather than experimented with new ones.

Another finding from the answers is that the business use of UCCs has shifted from the use of 2 UCCs in favor of none or 3 ones, while in 10 cases remaining the same as pre-COVID-19, namely 1 UCC being used.

Also single UCC use remained at the same level in private use, but users indicated a shift towards 3 and more UCCs while communicating remotely for private use. The reason for this situation might be the diversity of platforms that respondents were pushed to use after the pandemic was announced also due to a higher rate of distance communication between friends and family. This aspect might be investigated further in other papers.

The generic conclusion from this finding is that users tend to use one standardized UCC platform that allows them to feel the confidence of use as well as to benefit from more advanced options that are learnt thanks to longer and more extensive use of IT systems.

5. Limitations

Although the executed research and its findings are generic and comprehensive, there are some limitations to this study. Firstly, the research data was collected from students of one specialty, from one specific university. The research did not find any cultural differences in distance learning and communication. Secondly, the study uses basic statistical measures without cross analysis to enable a deeper analysis of the research. Future research might employ a wider group of respondents including Polish and foreign respondents. Thirdly, the study took the snapshot research approach within a short period of time, thus longer research would be beneficial for a better picture of the area.

6. Conclusions

The group of respondents represents working students who are familiar with various UCC platforms used for professional, educational and private purposes. Their possibility to gain hands-on experience prior to commencing the survey was to define the baseline for the research. Such an approach allowed the authors to draw conclusions on the features that experienced respondents value the most from the perspective of communication and collaboration, indicating the most preferable approach and UCC platforms in the common use.

The generic conclusion of the research was that almost all respondents (96%) had prior experience using UCC platforms. The announcement of the pandemic and recommended distancing and lockdown approach of governments pushed the whole society towards digital methods of communication. The survey has proved the almost 100% use of UCC across various areas of life.

Based on the research, it has been noticed that respondents tend to use one or two UCC platforms as a standard for business and private use. The rationale for that is in the general learning ability of end users to gain confidence and achieve fluency in features offered by those platforms.

Educational institutions tended to use a wide diversity of UCC platforms both prior to COVID-19 and during the first 3 months of COVID-19. Respondents highlighted the need to use at least 4 different UCC platforms, thus there is no single and unified approach across educational institutions, causing issues with building up the confidence in usability of those platforms. And on the other hand, it might indicate that educational institutions would

not create a global trend on the used communication channels and platforms and that the rate of faults might be higher due to limited and isolated testing of the population as well as a lower level of adaptability to end users' needs. The question that might need further investigation is why educational institutions in Poland prefer to choose non-standardized solutions to ensure cooperation and collaboration in the academic community. This is the question to be answered in upcoming research.

The single UCC use seems to be the most common approach and remained at the same level in private use. In opposition to business, where unification of UCC platforms was identified (1 or 2 platforms are commonly used), a change in pattern was observed in private use where the majority of respondents indicated a shift towards 3 UCCs. The reason for this situation might be the diversity of platforms that respondents were pushed to use after the pandemic was announced. Also, due to a higher rate of distance communication between friends and family, respondents needed to adjust to tools preferred by others including older representatives of the society who have a lower level of IT understanding and experience. The situation might have pushed experienced users to choose and identify other channels that are slightly less complex but at the same time easier for use for those less experienced in IT. The area should be investigated further.

UCC platforms that are more widely used across different areas of life and are rated as the most preferred by the respondents are Microsoft Teams (30%) and Google Meet (23%).

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DARQ Technology as a Digital Transformation Strategy in Terms of Global Crises

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Abstract

Purpose: The aim of the paper is (1) to analyze the DARQ (Distributed ledger, Artificial Intelligence, Extended Reality, Quantum Computing) technology in terms of its implementations and (2) to compare these technologies with the SMAC technology (Social, Mobile, Analytics, Cloud). We present the thesis that DARQ technologies can help in building information systems aimed at both predicting and monitoring global crises. We argue that the DARQ technology will support the management of network organizations in the first period of development.

Design/methodology/approach: The research procedure consists of the following steps: literature analysis, conducting qualitative research and its presentation, obtaining expert opinions and recommendations for further research.

Findings: The results of work on the DARQ technology that supports management systems allowed for the evaluation of usability both in terms of the expected effects and the areas of risk of application.

Research limitations/implications: Due to the lack of practical applications of all the elements that make up the DARQ technology, the analysis of such components as Extended Reality (Virtual Reality), Quantum Computing (Virtual Computing Technology) is not complete and requires complementary research and a more complete analysis of its applications. We consider the presented work as an introduction to broader research.

Originality/value: The thesis has been substantiated that the transition from SMAC to DARQ technology can be done gradually. Both of these technologies are compatible. This may result in gradual and collision-free changes in the quality of the management system. Elements of the new DARQ technology,

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such as Distributed ledger, Artificial Intelligence, Extended Reality and Quantum computing, allow for abrupt changes in both the management system and the functioning of the organization. Already today, each component of the DARQ technology has a significant impact on various sectors of the economy. However, it should be noted that apart from the positives, the DARQ technology also poses some threats. The article contains conclusions from the research and indicates a recommendation for further work, which concerns extending the application of DARQ technology to predict and monitor disasters and unpredictable events. To this end, we analyze the Black Swan theory (based on the COVID-19 pandemic case study) as the theoretical framework for the use of DARQ technology as a tool to reduce the occurrence of unpredictable events.

Keywords: DARQ, SMAC, Black Swan Theory, COVID-19, digital transformation strategy.

JEL: M15, H12, O32, O33

Technologia DARQ jako strategia transformacji cyfrowej w warunkach globalnych kryzysów

Streszczenie

Cel: celem artykułu jest: (1) analiza technologii DARQ (Distributed ledger, Artificial Intelligence, Extended Reality, Quantum Computing) pod kątem jej zastosowań; (2) przeprowadzenie porównania tej technologiemi z technologią SMAC (Social, Mobile, Analytics, Cloud). W artykule stawiamy tezę, że technologie DARQ mogą być pomocne do budowy systemów informatycznych mających na celu zarówno przewidywanie, jak i monitorowanie globalnych kryzysów. Uważamy, że zastosowanie technologii DARQ będzie w pierwszym okresie rozwoju wspomagać zarządzanie organizacjami sieciowymi.

Metodologia: procedura badawcza składa się z następujących etapów: analizy literatury, przeprowadzenia badań jakościowych i ich prezentacji, uzyskanie opinii ekspertów oraz propozycje dalszych badań.

Wyniki: efekty prac nad technologią DARQ wspomagającą systemy zarządzanie pozwoliły na ocenę jej użyteczności ze względu na spodziewane zarówno efekty, jak i sfery ryzyka zastosowania.

Ograniczenia/implikacje badawcze: z powodu braku zastosowań praktycznych wszystkich elementów składających się na technologię DARQ analiza takich części składowych, jak Extended Reality (rzeczywistość wirtualna), Quantum Computing (technologia obliczeń wirtualnych) nie jest pełna i wymaga badań uzupełniających i pełniejszej analizy jej zastosowań. Artykuł traktujemy jako wstęp do szerszych badań.

Oryginalność/wartość: uzasadniono tezę, iż przechodzenia z technologii SMAC do DARQ może odbywać się stopniowo. Obie te technologie są kompatybilne. Skutkować to może stopniowymi i bezkolizyjnym zmianami w jakości systemu zarządzania. Elementy nowej technologii DARQ, takie jak Distributed Ledger, Artificial Intelligence, Extended Reality, Quantum Computing pozwalają na skokowe zmiany zarówno w systemie zarządzania, jak i funkcjonowania organizacji. Już dziś poszczególne technologie DARQ silnie oddziałują na różne branże gospodarki. Należy jednak zwrócić uwagę, że obok pozytywów technologia DARQ stanowi również pewne zagrożenie. W artykule zawarto najważniejsze konkluzje płynące z badań oraz wskazano dalsze kierunki realizacji prac badawczych w tym zakresie.

Słowa kluczowe: DARQ, SMAC, teoria czarnego łabędzia, COVID-19, strategia transformacji cyfrowej.

1. Introduction

The 21st century is the age of innovation and rapid multilateral development of the economy. It is a period of changes, both positive ones as well as those resulting from global crises. The digital economy changes modern management fundamentally. In this paper, we would like to present

and focus on these changes, which result from the progress made in the digital technology. New technological solutions directly affect the tools that support modern management.

The main objective is to present and analyze the application opportunities arising from the newly emerging digital technology, which is abbreviated as DARQ (Distributed ledger, Artificial Intelligence, Extended Reality, Quantum). We present the digital technology development process perspective in the context of comparing it with the currently existing technology known as SMAC (Social, Mobile, Analytics, Cloud). The DARQ technology is a significant stage in the evolution of ICT (Information and Communication Technology). We analyze its applications as a tool supporting the construction of IT systems used in both forecasting and monitoring global crises. We also treat the DARQ technology as an innovative element in creating breakthrough solutions in economic progress. According to the Accenture report (2019), approximately 89% of organizations use at least one element of the DARQ technology¹.

In the usability research of the DARQ technology, special emphasis was placed on the analysis of the expected effects and risk of its use. They were presented in the context of the analysis of the effects and risks of SMAC technology.

The article was inspired by the Accenture report (2019) on the expected trends in digitization. The following research procedure has been used: the first stage of presented study is the analysis of the literature and published research reports. Then, based on our own research of the digital technology domain, we extended the analysis of risks presented by Benhayoun-Sadafiyine and Boughzal (2020).

Our research on management support systems allowed both for the evaluation of the risk sphere and for the determination of the expected effects of using DARQ technologies (Kisielnicki, 2012, 2013, 2017; Olszak & Kisielnicki, 2018; Kisielnicki & Sobolewska, 2019). The conducted research has been complemented by the opinions of digital technology experts that represented various industries. The analysis covered the development plans of software companies operating in Poland, such as IBM, SPA, Comarch, IFS, or Asseco. These analyses resulted in a synthetic Table 1 that presents the expected effects and threats of using SMAC and DARQ components. Table 2 summarizes synergistic effects and threats for described technologies. The final stage presents the possibilities of application of the DARQ technology during the COVID-19 pandemic and building a protection system against “Black Swan”. The term “Black Swan” is an allegory for determining unexpected dangers. In the summary of the paper, the main conclusions of the studies were formulated and further directions of the research indicated. While writing the article, we used mainly the research methods such as critical analysis of the literature, the deduction method and the experience and results of research on the implementation of

the aforementioned projects on computer-aided management, but expert opinions were also used.

The key four components of DARQ technology used individually are a very useful and powerful tool employed in practice to improve the management system. Individual effects are obtained from a standalone application such as Distributed ledger, Artificial Intelligence, Extended Reality, Quantum computing. As a result of the integration of the described technologies, they are enhanced by the synergy effect. This effect allows for achieving a new quality in management. As the article demonstrates, the DARQ technology also introduces new requirements. It can be argued that applications of the DARQ technology will support the management of network organizations in the first phase of development. This is due to their nature that requires technological connections between the management infrastructure of individual organizational entities. Such conclusions could be drawn as a result of the analysis of the effectiveness of building an interoperability platform for the ORLEN Corporation².

We consider the presented article as an introduction to broader research. Many of the issues raised are initially indicated and have to be developed in further research.

2. DARQ Technology as a Drive of Innovation in Formulating a New Management Strategy

The literature highlights the evolution of digital technology. It is often stated that we are on the threshold of the post-digital age. Currently, management is supported by the SMAC technology, which consists of the following components: Social, Mobile, Analytics and Cloud. Applications focus on solutions aimed at:

- building an information society,
- mobile solutions, described by the formula "my office is where my laptop is",
- development of various types of decision support systems, i.e. systems known as Decision Super Systems and Expert Systems,
- handling large sets/data files that are stored outside the facility where they were produced, i.e. in the so-called cloud.

The transition from SMAC technology to more advanced technology such as DARQ requires significant financial resources. Therefore, only large corporations and previously mentioned network organizations can opt for such solutions. However, there is a risk that SMEs (Small and Medium-sized Enterprises), under the influence of the ongoing changes, will increasingly (in terms of the management infrastructure) deviate from large organizations. Both of these technologies are compatible. This may result in gradual and collision-free changes in the quality of the management system. Elements of the new DARQ technology, such as Distributed ledger,

Artificial Intelligence, Extended Reality, and Quantum Computing allow for abrupt changes in both the management system and the functioning of the organization. Already today, each component of the DARQ technology has a significant impact on various sectors of the economy. However, it should be noted that apart from the positives, the DARQ technology also poses some threats. A description of these threats has been discussed in the following paragraphs.

The DARQ technology can be characterized by defining its components, features and applications:

Distributed ledger (DLT) has a more general meaning than blockchain technology (Arslanian & Fischer, 2019). It refers to databases stored on multiple digital devices, called system nodes. A key feature of distributed ledger is that recorded data is shared within the network without any central administration. Updates of the entire database are performed automatically and independently in each node while ensuring integrity through consensus-based validation protocols. The benefits mainly concern the simplification of the coordination of entries made in various public institutions – tax offices, banks, notary’s offices, regulatory offices – and they substantially increase the confidence in the data included in the database. The implementation of this technology has proved itself in logistics, which allows for the simplification, acceleration of the preparation and execution of specific transactions (Hackius & Petersen, 2017).

Artificial intelligence (AI) is a branch of computer science, the ability of a computer to operate in a way to mimic human intelligence (Minsky, 1968). For its application, the digital system that is used should have an enormous amount of information and appropriate procedures. The latter is modeled on the characteristics of human intelligence, which leads to the ability to process data independently, learn from the collected data, solve decision-making problems of varying complexity. Numerous applications of AI as a standalone module allow us to assess its high efficiency and great potential in decision-making processes (Chen et al., 2018; Edwards et al., 2000).

Extended Reality (XR) is a general term that includes Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR). Figure 1 shows the relationship between technologies from the real environment and those form the virtual environment based on the work of Milgram (Milgram & Kishino, 1994). Extended Reality (XR) refers to a combination of real and virtual reality using digital technology (Doolani et al., 2020). Depending on the virtual part of the application, it can contain a small or significant part. For instance, a small part is a tool for modifying simulation models of the real situation (the so-called augmented reality). An example of a significant part can be the construction of a complete virtual environment, which is based on data collected through our senses and various types of sensors. The effectiveness of this technology has been demonstrated by its applications in

the training of employees and in the modeling of the economy as a whole as well as in its respective industries. The technology is currently used in computer simulation of various real phenomena and processes. Recently, for instance, Volkswagen has been using quantum computing to simulate the chemical structure of batteries to improve and increase battery longevity (Koolwal & Khandelwal, 2020). Volkswagen has partnered with Nvidia to add AI features to future car models. The DML is also tested to protect cars from hacker attacks, facilitate automatic payments at gas stations, create secure mileage counters and so on. What is more, Volkswagen provides service in cars repairs through the XR.

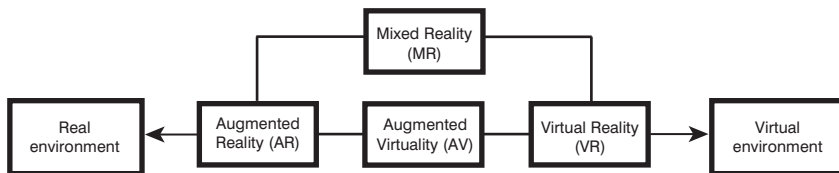


Fig. 1. Relation between Extended Reality (XR) technologies. Source: Adapted from Milgram and Kishino, 1994.

Milgram and Kishino define the concepts of Extended Reality by placing it on a scale whose extremes are the real environment (left side) and the virtual environment (right side). As you move to the right, the degree of stimulus generated by the computer increases.

Quantum computing, which is a quantum computing technology (Gruska, 1999), refers to the quantum computer that performs specific operations. Quantum computing uses quantum mechanics principles and quantum algorithms (Ying, 2010). To solve specific computational problems, these algorithms use basic quantum unit of information – qubit. Quantum computers differ from classical computers in that, in addition to values 0 or 1, they can hold a full range of all possible states. Thus, the qubit is capable of storing and carrying much more information than a bit, thanks to which its efficiency is many times higher³. At the time of formulation of this paper, i.e. the beginning of 2021, the technology is not ready for widespread use. The intensity of the work carried out, the amount of funds spent and the involvement of scientific institutions are the announcement that in the near future quantum computers will process big data/data files. An example of the changes offered by this technology is the acceleration of calculations. Quantum computing is expected to drive new innovations in the coming years.

The last element of the DARQ technology, Quantum, is now the element that makes the DARQ technology possible to use to a limited extent. The complexity of the world requires very complex calculations. Therefore, the development of DARQ technology depends both on the interconnection of

the four elements of technology as well as on the technology of quantum computing.

Two stages can be distinguished in the application of DARQ technology:

The first stage is a present state, in which the architecture is represented in Figure 2, and refers to the independent development of individual elements. They function side by side and realize their development independently. They are closely related to the existing digital SMAC technology.

The second stage presents the target architecture image. Figure 3 demonstrates the DARQ technology as one system.

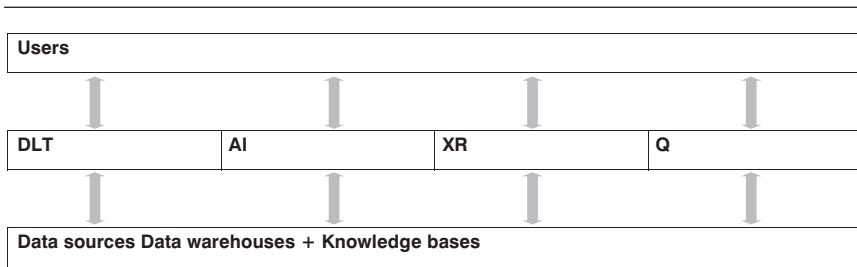


Fig. 2. Current architecture of DARQ technology (as element platform). Source: Own work.

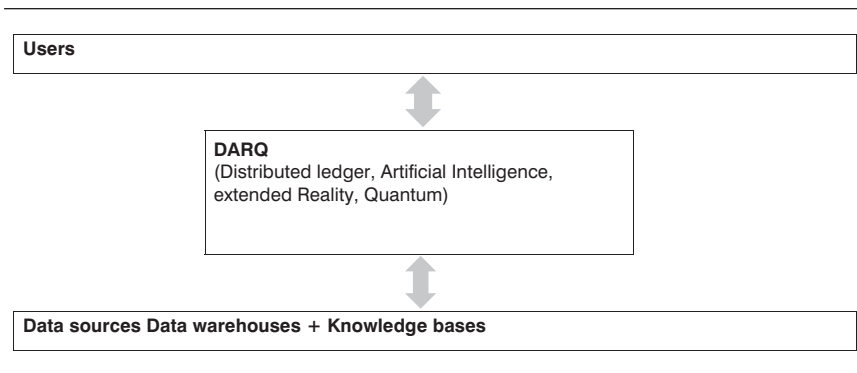


Fig. 3. Target architecture of DARQ technology. Source: Own work.

Figure 2 represents a situation where each of the four DARQ technologies is used by an organization individually to differentiate its products and services from competitors. Figure 3 presents the interrelationships of these four partial technologies.

Based on interviews, correspondence and literature analysis, it can be concluded that it would be difficult to select an organization that fully uses the DARQ technology. However, in many cases, we are dealing with the use of combined technologies. This is particularly true of the relationship

between AI and XR in a domain such as medicine or education. Already now, in many financial solutions, AI and DLT offer organizations an advantage over their competitors. For example, VOLVO is working to merge DLT and AI. It can be assumed that quantum solutions – quantum computers will inspire new innovations in the coming years.

3. Effects and Risks of SMAC and DARQ Technologies in Literature and Own Research

Qualitative studies on the effects and risks on SMARC and DARQ technologies were aimed at answering the following research questions:

1. What effects and risks can we expect in the application of SMAC and DARQ technologies?
2. What effects and risks will we receive as a result of the combination of SMARC and DARQ technology components, what are the benefits and threats in the overall implementation of both technologies – synergy effect?

The current research is a continuation of previous analyses on the effectiveness of ICT applications conducted by J. Kisielnicki (1981, 2012, 2017). The benefits and risks presented in Tables 1 and 2 usually have a business dimension. Their materialization results both from the SMARC and DARQ technology itself, but also from its application. The effects and risks that we expect while implementing new technologies are mostly economic and business-related. Without calculations, it would be unprofitable to invest time and funds in a new technology. The following assumptions were made in the conducted research. The obtained effects and risks related to the application of each digital technology depend not only on the hardware and software used but also on the applications and qualifications of the people who use them. In the process of organizational transformation, we have to be aware that the use of SMAC and DARQ technologies bring benefits to the organization, but they also carry risks. This risk has an economic, ethical and technical dimension. Due to the synergy effect, the overall use of SMAC and DARQ technologies will result in significantly greater effects than in the case of individual components. We observe new opportunities of combined technologies especially in medicine (Dugstad et al., 2019). It is emphasized in the literature that the DARQ technology in particular initiated a new era in medicine⁴. Significant effects in human treatment have been achieved by using the Quantum module in conjunction with AI. DARQ is a revolution in computing thanks to its fast processing as well as advances in the functioning of the internet and data encryption⁵. The performed preliminary analyses are intended to prepare assumptions for in-depth research. The issue of analyzing the effects and risks of the modern digital era and the current post-digitization period is presented, *inter alia*, in the Accenture report (2019).

3.1. Research Procedure

The following research procedure was implemented:

Step I – Literature research in terms of the effects and risks of digitization. In this step, there was no problem with the discernment of SMAC technology (Sitarska-Buba, 2017; Dewan & Jena, 2014; Cornelius, 2013), while in the field of DARQ technology, we had limited access to information. In response to an inquiry sent to large software companies, only IBM-Poland stated that it intended to intensify work on the DARQ technology. The issue of the risk of SMAC and DARQ technology is dealt with in the paper of L. Benhayoun-Sadafiyine and I. Boughzal (2020). This publication demonstrated the opinion of five experts on the risk of unpredictable situations in the use of both technologies.

Step II – Qualitative research in the focus group. A group discussion focused on the effects and risks of SMAC and DARQ technologies was conducted. Research on both the SMAC technology and one element of the DARQ technology, namely AI applications, was conducted in April 2018. At that time, information about the DARQ technology as a whole was still very scarce. The focus group was about 30 people. The discussion was conducted during the classes in the subject of Computer Science in Management at the MBA studies at the Lazarski University⁶ The participants of the group were people with higher education, where 6 people worked directly in the IT department. Most of the participants (25 people) were at the middle management level. As a result of the work, synthetic tables on the effects and risks of individual SMAC and AI technologies were developed. The participants did not know the other elements of the DARQ technology.

Step III – Elaboration of synthetic tables based on literature, a risk table of SMAC and DARQ technology elements developed by L. Benhayoun-Sadafiyine and I. Boughzal (2020) and the results of the qualitative study in the focus group.

Step IV – Selection of experts to evaluate the developed preliminary synthetic tables and propose their modification. Nine experts were selected: five with doctoral degrees in management and four with advanced doctoral dissertation in management. Five people had technical education (graduates of polytechnics). The experts had at least 10 years of experience in the IT sector.

Step V – Forms distributed to experts, asking for evaluation and modification. Elaboration of results and their presentation in Table 1 and Table 2.

Step VI – Elaboration of a schedule of further work and preparation of an application for a research grant to the NCBiR.

3.2. Findings

The results of the study are demonstrated in Tables 1 and 2.

Technology	Elements	Effects. What effects can we expect?	Risks. What risks can we expect?
SMAC			
	Social	<p>Development of information society.</p> <p>New marketing channels.</p> <p>New opportunities to reach and interact with a customer.</p>	<p>Negative publicity (damage in terms of image).</p> <p>Harassment, mobbing.</p> <p>Development of harm measures (including filter bubble, fake news).</p>
	Mobile	<p>Improving the communication system between individuals of society.</p> <p>Improving the quality of functioning: government, banks, etc.</p> <p>Increase in labour mobility.</p> <p>Easier access to information systems (e.g. by synchronizing a smartphone with a computer)</p> <p>Reach the customer more effectively.</p>	<p>Access to private data.</p> <p>Cyber attack.</p> <p>Identity theft.</p> <p>Personal data theft.</p>
	Analytics	<p>Objectivization of decision making.</p> <p>Analysis of development trends of various objects such as industries.</p> <p>Analysis of market behavior.</p>	<p>Measurement errors.</p> <p>Non-compliance with the GDPR.</p> <p>Data manipulation (fingerprints, genomes, etc.).</p> <p>Risk related to the sensitivity of the shared data.</p>
	Cloud	<p>The ability to operate large data sets.</p> <p>Reduction of data storage and data sharing costs.</p> <p>Overcoming geographical barriers.</p>	<p>Data security / leakage.</p> <p>Personal data protection.</p> <p>Threat to the sovereignty of the country.</p> <p>Loss of property.</p>

Table cont.

Technology	Elements	Effects. What effects can we expect?	Risks. What risks can we expect?
DARQ			
	Distributed ledger including blockchain.	Increased security of the transactions. Expanding financial transaction networks. Elimination of trusted third parties.	Financial fraud. Useless investment. No legal regulations.
	Artificial Intelligence	Plays a key role in process optimization and decision-making at various management levels. Replacing labor in various positions. Advisory function, i.e. legal, financial.	Algorithms have not been mastered. Self-learning algorithms can take control of some processes. Misuse. Usage scam. Conditions for opportunistic behavior.
	Extended Reality	New ways of experiencing the surrounding reality Visualization and 3D simulation as a way to learn and improve skills. Reducing the need for movement. High commitment.	Unnecessary investment decision. The risk of using unmastered technology. Limited availability of broadband internet. Privacy protection. An immersive environment may pose a threat to the user's health.
	Quantum computing	Innovative ways to solve the most difficult computational problems.	Excessive capacity to oversize to react to trivial problems. The risk of using unmastered technology.

Tab. 1. Expected effects and threats from the use of technology elements: SMAC [Social, Mobile, Analytics, Cloud] and DARQ [Distributed ledger DLT, Artificial Intelligence AI, Extended Reality XR, Quantum computing]. Source: Own work and a part of risk identification based on L. Benhayoun-Sadafiyine and I. Boughzala (2020).

Effects. What effects can we expect?		Risks. What risks can we expect?	
SMAC	DARQ	SMAC	DARQ
<p>The emergence of new business models*.</p> <p>Building relations with clients (i.e. contact anywhere, anytime).</p> <p>Improving the decision-making process* (i.e. by better understanding customer needs).</p> <p>Faster access to and flow of information.</p> <p>Increase in the efficiency of organization* (e.g. by managing product flows).</p> <p>Lower information processing costs.</p>	<p>Reduction in financial outlays*.</p> <p>Obtaining an effective tool for crisis monitoring.</p> <p>Higher quality of the management system.</p> <p>Eliminating burdensome and time-consuming activities.</p> <p>Opportunities of using dedicated dashboards.</p> <p>Simulation of the effects and risk evaluation of various development strategies.</p> <p>Customization (personalization) of products and services.</p>	<p>Greater dependence on external suppliers*.</p> <p>Lack of confidence in new technologies*.</p> <p>May lead to user additions.</p> <p>The need to use specialized personal data protection systems.</p> <p>The need for highly qualified technical and operational staff.</p> <p>Dependence of the management system on technological solutions*.</p>	<p>The risk of system failure is greater than that of individual components of technology*.</p> <p>Changing the development strategy may lead to personnel and financial problems.</p> <p>High entry barrier.</p> <p>Promoting: negative patterns, unethical behavior, nationalist ideas, etc.</p>

* observed in both SMAC and DARQ technology

Tab. 2. Expected synergistic effects and risks from the SMAC and DARQ technologies. Source: Own work and a part of risk identification based on L. Benhayoun-Sadafiyyine and I. Boughzala (2020).

By analyzing the characteristics of both technologies listed in Tables 1 and 2, we would like to draw attention to the following:

1. The characteristics of both effects and risks are qualitative and the description of both technologies has no classification features (uniqueness and completeness) and in the future, after a full analysis, and not as a pilot one, the fuzzy set theories should be applied.
2. The SMAC technology can be implemented by almost every company in Poland. SMAC was an opportunity for small businesses. Small, family-run or small-town businesses can, with the relatively low financial outlay and through the use of social media, reach customers from all over Poland. This way, they can gain a competitive advantage. The analytics of this data in basic form is provided free of charge and is relatively

- inexpensive. Thanks to improved, direct communication, small companies can conduct effective marketing activities, building their credibility and loyalty among customers. For instance, a small family sewing plant sewing children's clothes, thanks to social media, was able to obtain orders for its products throughout the country from individual customers, and then analyze the profile of the buyer or visitor to its store.
3. The DARQ technology is currently not fully used. It is difficult to assess both in terms of effects and threats. Its use is costly and with the introduction of Quantum computing solutions, it will require fundamental changes in the management infrastructure. The technologies in question are capital-intensive investments.
 4. It can be argued that all SMAC effects (results) will become, in a qualitative sense, the results of the DARQ implementation. The exception is "lower information processing costs". The issue of risk is similar. The relationship between the risk of using SMAC technology and the risk of DARQ technology is one-way. This means that SMAC risks are DARQ risks simultaneously, but DARQ risks are not SMAC risks. The exemplification is the entry barrier, where it is low in SMAC, and high in DARQ. It can be hypothesized that the relations of development trends are one-sided, which may result in significant transformation costs that will arise under new, unpredictable threats.
 5. SMAC and DARQ technologies should not be viewed as competing with each other. This means that SMAC technologies will not be completely replaced by DARQ technologies in the future, but only enriched with DARQ achievements.
 6. The research results in this section of the paper should be continued in terms of the quantification of both technologies. This mostly relates to effects and costs. Such studies will be recommendations for organizations as to the legitimacy of spending on hardware, software and training of users of the described technologies.

Black Swan Theory and the Experiences of Occurrence the COVID-19 Pandemic. Recommendation of Elaborated Research on the DARQ Technology and Implementation to Predict and Monitor Disasters and Unpredictable Events

The theoretical framework of the „Black Swan” is presented in the book titled *The Black Swan: The Impact of the Highly Improbable* written by American scholar Nassim Taleb. The Sunday Times recognized it as one of the most important books written since the Second World War (Appleyard, 2009). Taleb describes the Black Swan phenomenon as a rare, unpredictable event that meets three conditions: firstly, it is unexpected and subjectively very unlikely; secondly, it has a huge impact on reality; thirdly, after its occurrence, it seems that the event was predictable and explainable, and thus becomes rationalized in retrospect (Taleb, 2014). Taleb concludes that examples of Black Swan events can be considered as the rise of the

internet, the outbreak of World War I, the collapse of the Soviet Union, or the terrorist attacks on 11 September 2001. As Kisielnicki notes, the consequence of the presence of the Black Swan is that what we do not know is more important than what we already know (Kisielnicki, 2021).

We argue that DARQ technologies could become a useful tool for predicting, monitoring and counteracting Black Swans. We also claim that DARQ technologies can be used to effectively counter the negative effects of the COVID-19 pandemic.

The coronavirus pandemic spread in a short time from Wuhan, the capital city of Hubei Province in China (Li et al., 2020), is certainly a rare event with unpredictable consequences, although it should be noted that historically, epidemics have occurred repeatedly. Giving the example of the pandemic of Spanish flu, lasting from 1918 to 1920, the death toll is estimated at 39 million people. It is estimated that the number of deaths then constituted up to 2.0% of the global population at that time (Barro et al., 2020).

Some scholars refer to the Gray Rhino metaphor (Lindhouta & Reniers 2020) in the context of the COVID-19 pandemic. Compared to Taleb's metaphor, it reflects a probable but ignored threat (Wucker, 2016). This sentence seems to be confirmed by Taleb himself, who calls the SARS-COV-2 pandemic a white swan due to the lack of an element of unpredictability (Swango, 2020). Although epidemics themselves, as well as wars or collapses of superpowers, are not something unknown or new, it should be considered whether in such a globalized world it was possible to predict the scale of the consequences caused by the coronavirus pandemic, i.e. the outbreak of a social, economic or health crisis (McKee & Stuckler, 2020). Thus, we argue that the COVID-19 pandemic and its unpredictable effects should be considered a Black Swan. We would like to highlight that in this paper, it was not our intention to start an academic discussion on this issue. Regardless of the metaphor or the nature of a catastrophe, we are talking not only about learning from the current pandemic, but above all about the current ICT risk management practice in the 21st century, especially in the context of growing uncertainties, i.e. new diseases, natural disasters, economic crises, etc., events that are difficult to predict, but have a similar disproportionate impact on reality. It is important to do a retrospective analysis of events in order to be better prepared for them in the future.

When building models to protect against the effects of the Black Swan, two assumptions should be taken into consideration: (1) the future cannot be predicted; therefore, it is not worth relying on experience and historical data; (2) the processes taking place in the world are too complex to fully understand and quantify them. Therefore, when building predictions, even the most unlikely scenarios should be analyzed. For this purpose, it might be advisable to construct a computer system using Quantum computing (Q) and Artificial Intelligence (I) technologies to build simulation models.

Most blockchain projects are currently in the proposal phase (Abd-alrazaq et al., 2020), but have several potential implementations that may contribute to a faster end of the coronavirus crisis. Applications include simplification of vaccine and drug clinical trials and data tracking. The benefits of blockchain technology, i.e. maintaining confidentiality and trust in collecting and reporting data, will affect the level of security of the collected information (Marbough et al., 2020).

Big data and Artificial Intelligence (AI). These technologies are used by countries such as China, Singapore and Taiwan to track people and thus limit the spread of infection. Tools such as migration maps, mobile payment apps, payment card usage, and social media activity are used to collect real-time data about the location of people (Whitelaw et al., 2020). Based on this data, machine learning models were developed to predict the regional transmission dynamics of coronavirus COVID-19 as well as to maintain movement restrictions. South Korea has implemented additional tools using surveillance footage, facial recognition technology and GPS to get the most detailed information on people's movements. Leaving aside ethical and legal aspects, such as the mortality rate per million inhabitants, as well as the total number of cases, the country ranks among the least affected among highly developed countries⁷. A research team from the University of Oxford concludes that tracking people can slow down or completely stop the spread of COVID-19 (University of Oxford, 2020). In addition, Artificial Intelligence is used for patient diagnostics, i.e. diagnosis based on a chest radiograph (Rosebrock, 2020), epidemiological modeling, infodemiology or better understanding the nature of the coronavirus (Mohammad & Tayarani, 2020, Abd-Alrazaq et al., 2020).

The role of augmented reality is emphasized in the literature. Technology was successfully implemented to study biomolecular structures through 3D visualization, which enables a better understanding of the virus mechanism of action and accelerates the process of drug discovery (Calvelo et al., 2020). It is expected that the emerging tools will be permanently introduced by scholars to drug development processes. The quantum computing technology has been committed to fighting the effects of the pandemic. In March 2020, the White House Office of Science and Technology Policy and the US Department of Energy formed the COVID-19 HPC consortium consisting of research departments and IT industry leaders such as IBM, Google Cloud, Microsoft, NVIDIA and Intel (the full list can be found on the consortium's official website⁸), as well as the US federal government to provide computing power at the level of 600 petaflops⁹ to research teams working on issues related to the coronavirus pandemic. It was possible to perform a molecular simulation on the SARS-CoV-2 protein, which allowed the identification of several potential drugs that may interact intracellularly with this viral protein. For researchers who will have access to the consortium's computing

capabilities, it is expected that after carrying out the research, they will publish their results in the open scientific literature.

The described theory of the Black Swan is valuable for an explanation of the mechanisms of unexpected events. We claim that ICT tools are extremely useful, especially mathematical modeling systems and fuzzy sets. The paper demonstrated the theoretical framework and justification for the building of an IT system for predicting and monitoring the Black Swan event. As shown in the given examples, currently DARQ technologies can largely be used against the Black Swan, which in our opinion is the COVID-19 pandemic. We recommend continuing research work on the development of assumptions for the implementation of a prediction and monitoring system.

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Endnotes

- ¹ Likely refers to large organizations with revenues in excess of \$ 250 million (accessed on 19.01.2021).
- ² Kisielnicki 2018 – Management Expertise – typescript.
- ³ Komputery kwantowe zmienią świat biznesu. Jak przygotować firmę? MIT Sloan Management Review Polska (accessed on 9 August 2019).
- ⁴ Kavita Sharma and Padmavat Manchikanti (2020), *Regulation of Artificial Intelligence in Drug Discovery and Health Care*, Published Online:7 Oct 2020.
- ⁵ Yash, Vishakha Sehdev, Ankit Verma: Issue 10, pp. 62–68.
- ⁶ At that time, J. Kisielnicki was the director of the Postgraduate Education Center and a lecturer.
- ⁷ Based on: <https://www.statista.com/statistics/1104709/coronavirus-deaths-worldwide-per-million-inhabitants/>, accessed on 14 January 2021.
- ⁸ <https://covid19-hpc-consortium.org/>, accessed on 12 January 2021.
- ⁹ PFLOPS is a computer system capable of performing one quadrillion (10^{15}) floating-point operations per second.

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Fake News as a Barrier in the Process of Communicating Information

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Abstract

Purpose: The main purpose of this study is to present fake news as a barrier to communication, awareness of its existence and perception from the point of view of individual users. On the basis of a literature review concerning the phenomenon of fake news, the aspects connected with the functioning of this type of news in the information space were indicated. The results of the research on the influence of fake news on the process of information transfer and the opinions of users – information recipients – are presented. The results are discussed and summarized in the form of synthetic conclusions. The directions of future research related to this topic are also outlined.

Design/methodology/approach: Based on the author’s previous experience related to surveying selected student groups, in order to achieve the adopted research goal, the survey questionnaires were distributed using the CAWI (Computer Associated Web Interview) method.

The adopted approach consisted of the following stages: justification of the method of selecting the sample for pilot and main research and informing respondents about the possibility of completing the survey; constructing a prototype of a survey concerning the place and role of fake news in the communication process; substantive verification of survey questions on a randomly selected pilot sample of students; preparing the final form of a quantitative and qualitative survey, testing it and placing it on the servers of the Faculty of Management at the University of Warsaw; conducting surveys among randomly selected student groups as well as the analysis and discussion of the results; drawing conclusions from the obtained results.

The method of selecting the test sample was random selection – the first 20 people were selected from those responding to the request for verification of the research survey. After revisions of the test sample, specific class groups were randomly selected from among all student groups to administer the survey in its targeted form. The sample selection itself was one of purposive sampling, determined in part by the random selection of pilot and lab groups. The survey was a pilot study and will be repeated to confirm the results obtained and to refine the conclusions.

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Findings: On the basis of the survey, the phenomenon of fake news is presented as assessed by the recipients of information in the context of the barrier it poses in the process of its transmission. The results are presented in the following scopes: fake news features; the impact of fake news; the perception of received messages as potentially fake news; recipients' reaction to fake news; publishing or posting fake news. Each of the above areas is discussed in the body of the paper. The study is summed up by formulating conclusions and outlining directions for further research in this area.

Research limitations/implications: A limitation of this study is the fact that the sample selection used a convenient variant; the students were randomly selected for the study from particular groups and belonged to a group of young people. This limitation, however, was intentional, because almost all participants of the study (98%) belonged to the age group of 18–30 years, which is an experienced and active group of internet users in Poland. Another limitation of the study resulting from the sample selected was that the respondents were not diversified socially, professionally or economically. The results of this study cannot be generalized to a larger population. Therefore, further research will be extended to other age, professional and social groups. An attempt will also be made to conduct a study in other geographical locations based on cooperation with friendly academic centers.

Originality/value: The presented material is of high cognitive value. It contains the results of the author's own research – it presents new content, not previously published in the literature on the subject in question. It enriches the literature in that it presents fake news as a barrier occurring in the process of communication and causing disturbances in the process of its transmission. The presented results may also constitute a basis for further research – also by other authors – as well as create a platform for a broader discussion on the phenomenon of fake news.

Keywords: fake news, barriers, communication, disinformation, post-truth.

JEL: D83, L15, L86

Fake news jako bariera w procesie przekazywania informacji

Streszczenie

Cel: przedstawienie wiadomości typu fake news jako bariery w komunikacji, świadomości ich istnienia oraz postrzegania z punktu widzenia użytkowników indywidualnych. Na bazie przeglądu literatury dotyczącej zjawiska fake news wskazano aspekty związane z funkcjonowaniem tego typu wiadomości w przestrzeni informacyjnej. Zaprezentowano wyniki badań wpływu wiadomości typu fake news na proces przekazywania informacji oraz opinie użytkowników – odbiorców informacji. Przedstawione wyniki zostały poddane dyskusji oraz podsumowane w postaci syntetycznych wniosków. Należy także kierunki przyszłych badań związanych z tą tematyką.

Metodologia: korzystając z wcześniejszych własnych doświadczeń, wynikających z przeprowadzonych badań ankietowych grup studenckich kwestionariusze rozprowadzono metodą CAWI. Przyjęte podejście składało się z następujących etapów: uzasadnienie sposobu wyboru testowej i docelowej próby badawczej oraz powiadomienie respondentów o możliwości wypełnienia ankiety; skonstruowanie prototypu ankiety na temat miejsca fake news oraz ich roli w procesie komunikacji; weryfikacja merytoryczna pytań ankietowych na losowo wybranej testowej grupie studentów; skonstruowanie ostatecznej postaci ankiety ilościowo-jakościowej, przetestowanie jej oraz umieszczenie na serwerach Wydziału Zarządzania Uniwersytetu Warszawskiego; przeprowadzenie ankiet wśród wylosowanych grup studenckich oraz analiza i dyskusja wyników; wyciągnięcie wniosków z uzyskanych wyników.

Sposób wyboru próby testowej był wyborem losowym – wybrano pierwsze 20 osób z odpowiadających na prośbę o weryfikację ankiety badawczej. Po jej zmianach, wylosowano wśród wszystkich grup studenckich konkretne grupy zajęciowe do przeprowadzenia ankiety w postaci docelowej. Tak więc sam

wybór próby należał do grupy celowych, determinowanych częściowo losowym wyborem grupy pilotowej i grup laboratoryjnych. Badanie miało charakter pilotażowy i będzie powtarzane w celu potwierdzenia otrzymanych rezultatów oraz doprecyzowania wniosków.

Wyniki: na podstawie przeprowadzonej ankiety przedstawiono zjawisko fake newsów w ocenie odbiorców informacji w kontekście bariery jaką stanowi ono w procesie jej przekazywania. Wyniki zostały zaprezentowane w następujących zakresach: cechy fake newsów; oddziaływanie fake newsów; ocena odbieranych wiadomości pod kątem fake newsów; reakcja odbiorców na fake newsy; publikowanie fake newsów. Każdy z zakresów został w treści opracowania omówiony. Opracowanie zostało podsumowane sformułowaniem wniosków końcowych oraz nakreśleniem kierunków dalszych badań w przedmiotowym zakresie.

Ograniczenia/implikacje badawcze: ograniczeniem niniejszego badania jest fakt, że przy doborze próby zastosowano wariant wygodny, studenci byli wybierani do badania losowo z poszczególnych grup, należeli do grupy ludzi młodych. Miało ono jednak charakter celowy, ponieważ prawie wszyscy uczestnicy badania (98%) należeli do grupy wiekowej 18–30 lat, czyli doświadczonej i aktywnej grupy użytkowników Internetu w Polsce. Ograniczeniem badania wynikającym z wybranej próby było także, iż respondenci byli mało zróżnicowani pod względem społecznym zawodowym oraz ekonomicznym. Uzyskanych w rezultacie niniejszych badań wyników nie można więc uogólnić na większą populację. W związku z tym kolejne badania zostaną rozszerzone na inne grupy wiekowe, zawodowe i społeczne. Podjęta zostanie także próba przeprowadzenia badania w innych lokalizacjach geograficznych w oparciu o współpracę z zaprzyjaźnionymi ośrodkami akademickimi.

Oryginalność/wartość: zaprezentowany materiał charakteryzuje się dużą wartością poznawczą. Zawiera wyniki autorskiego badania – prezentuje treści nowe, dotychczas niepublikowane w literaturze przedmiotu. Wzbogaca on literaturę przedmiotu w zakresie prezentacji zjawiska fake-news jako bariery występującej w procesie komunikacji oraz powodującej zakłócenia w procesie jej przekazywania. Przedstawione wyniki mogą stanowić także bazę wyjściową do dalszych badań – również przez innych autorów oraz stworzyć płaszczyznę do szerszej dyskusji o zjawisku fake news.

Słowa kluczowe: fake news, bariery, komunikacja, dezinformacja, post-prawda.

1. Introduction

In the contemporary world we live in, in the information society, information is of key importance for the functioning of individuals, states and societies. Its transmission is conditioned by the process of effective communication, the disruption of which may have serious and sometimes even unpredictable consequences. It is important to note that communication itself may be a barrier to the proper functioning of many projects, e.g. the implementation of IT systems (Parys, 2017).

The main purpose of this study is to present fake news as a barrier to communication, increase the awareness of its existence as well as analyze its perception from the point of view of individual users. In order to implement the research goal, the following structure of the study has been adopted. After the introduction, based on literature analysis, fake news is presented as a media phenomenon and characterized in relation to other phenomena emerging in contemporary communication such as disinformation or post-truth. Subsequently, the author describes the methodology of the conducted research, followed by a presentation and discussion of the results obtained

in the study. Finally, conclusions are formulated and directions for further research are outlined in the last sections of the paper.

The analysis whose findings are presented in this article is based on primary research carried out with the participation of a sample of students of the Faculty of Management at the University of Warsaw. A detailed description of the methodology and particular stages of the study is provided in the subsequent sections of the article.

In order to select the respondents participating in the study, the author applied a method of convenient sampling. The students from particular groups were randomly selected and invited to take part in the survey. They represented a population of young people, which was one of the limitations of this study. The abovesaid limitation was deliberate since nearly all participants (98%) belonged to the 18–30 age group, i.e. an experienced and active population of internet users in Poland. According to data published by Eurostat (referring to the entire population), in Poland, 99% of young people aged 16–34 and 96% of people aged 35–44 use the internet (Benchmark.pl, 2021). Another limitation of the study resulting from the selected sample was the fact that the respondents were not diversified in terms of their social, professional and economic characteristics. However, taking into account the fact that the analyzed study was of a pilot nature, and its results will only be used as a preliminary stage for further research and will not be generalized to a larger population, the indicated limitations did not prevent the author from formulating relevant conclusions. A similar procedure for selecting the research sample was used in the author's previous works, including the latest co-authored studies devoted to the role of information technology in organizations (Chmielarz et al., 2021).

The author decided to undertake the this research for two reasons. One cause was the natural desire to explore a phenomenon, which is a basic characteristic of an inquisitive researcher; the second motivating factor was the fact that there are few discussions concerning the issue of fake news as a barrier to the communication of information in available publications. Extensive literature on the subject, both Polish and English language sources, presents fake news and related problems concerning communication and information transfer in a number of contexts. It is perceived as a socially dangerous phenomenon or a threat to democracy (Tomaszewska-Michalak, 2021), a tool for transmitting manipulated information impacting young people (Szulc, 2020), and also as a problem which should be addressed and counteracted by international institutions and selected EU countries, including Poland (Ogrodowczyk et al., 2020). In the author's opinion, the research and publication potential of the topic under consideration is so vast that in the near future the abovesaid research gap may be filled or significantly reduced in the literature.

In the present conditions of a pandemic and considering the fact that most activities are currently performed remotely and information

is transferred online, communication and its proper transmission are of particular importance. It is an unprecedented situation in the history of both Poland and the entire world. Bearing this in mind, fake news appears to be an inseparable element of this process, and selected aspects of its impact on the information provided will be presented in this study.

2. Fake News in the Literature on the Subject

The notion of “fake news” is a neologism and it is difficult to provide a unanimous definition of the term. “It is a media message that contains real elements and relies on disinformation” (Bąkowicz, 2019). Fake news can also be defined as untrue, inaccurate, deceitful or manipulated information. By breaking the postulate of truth and disrupting the axiological context of the sender-recipient relationship, it makes it impossible to recognize the actual events and give the correct meaning to facts (Chyliński, 2018). The dictionary of the Polish language states that fake news is “a method of manipulating facts that is eagerly used by journalists whose aim, when preparing a publication, is to maximally increase the interest in the subject, and not give an account which is compliant with reality” (sjp.pl, 2021).

In the literature concerning the definition of the term “fake news”, doubts also arise as to the scope of the term. English-language scientific articles published in the years 2003–2017 where the term “fake news” was used present it in different meanings and various contexts. They range from satire or parody and end with propaganda and manipulation (Tomaszewska-Michalak, 2021). Regardless of the lack of the unanimous definition of fake news or disinformation, still, common features of this undesirable phenomenon can be distinguished. Thus, it emerges as purposeful and conscious dissemination of false (or partially false) information in order to obtain certain material, political or personal benefits (Tomaszewska-Michalak, 2021).

The term “fake news” is not new. The dissemination of false or unverified information has been known since ancient times. As an example, although much more recent, one can refer to the so-called “great moon deception” of 1835, in which *The New York Sun* published a series of articles about the discovery of life on the moon. A slightly more recent example is the 2006 “Flemish secession hoax”, in which a Belgian TV station reported that the Flemish Parliament had declared independence from Belgium (Allcott et al., 2017).

However, the meaning of the term “fake news” has changed over time. Nowadays, with global media coverage, this phenomenon can be described as “news articles” that are deliberately falsified and may mislead readers (Edson et al., 2018).

The term “fake news” can also be sometimes replaced by “alternative facts”, which indicates a message that is devoid of logical sense (Szulc, 2020).

It should also be noted that the term “fake news” is used in a fairly wide range of meanings. It is applied both to single false or untrue news or to a more complex phenomenon related to disinformation (Ogrodowczyk et al., 2020).

Ease of access to universal communication tools also means that professionals are replaced by amateurs. The possibility of disseminating any type of content threatens cultural standards and accepted values. Virtually everyone, without any major restrictions, can publish any content on the web, including information that may be referred to as fake news (Szulc, 2020). The universal access to the internet and the popularity of social networking sites act as a specific catalyst for such activities.

Due to the wide range of definitions, a two-fold approach to the concept of fake news appears to be a justified course of action in this context. A narrow definition reduces false information to such which can be verified by checking the facts and discovering their origin. It also helps to identify the source of fake news and thus remove or delete it. A broad definition covers deliberate attempts to disinform the public and distort messages to promote ideology, confuse audiences and polarize society (Bąkiewicz, 2019).

Fake news can also be associated with advertising and form a specific foundation of business activities. The literature gives an example of the Coca-Cola company, which has built its brand on the association of the consumption of its carbonated drink with youth, efficiency and joy. Coca-Cola encourages consumers to drink the beverage using the above positive associations, while in fact, drinking Cola contributes to the occurrence of, among others, diabetes or heart conditions (Bąkiewicz, 2020).

When considering the subject of fake news, one should distinguish between deliberate falsification of information and accidental action. Content that is similar to fake news (referred to in the literature as cousins) include (Szulc, 2020; Allcott et al., 2017):

- false information (unconfirmed facts) unintentionally provided by newspapers or websites and then corrected or denied,
- gossip,
- satire misinterpreted as truth,
- false statements by politicians duplicated by the media;
- distorted information, e.g. false conclusions based on true premises,
- conspiracy theories (which some people believe in, e.g. about aliens, secret organizations or the activities of secret services).

The contemporary global discussion on “fake news” began after the events of 2016. They were related to the presidential elections in the US and the campaign of D. Trump. His competitor for the presidency was H. Clinton. False information disseminated online, such as the alleged sale of weapons to the ISIS terrorist organization, significantly influenced voters’ decisions and, consequently, led to the victory of D. Trump (Szulc, 2020).

During this presidential campaign, 115 false stories were prepared in favor of D. Trump called “pro-Trump” stories, which were shared (as “fake news”) on Facebook a total of 30 million times, and “only” 41 false stories of “pro-Clinton” character which were shared a total of 7.6 million times (Allcott et al., 2017).

In Europe, the disinformation technique was used in the referendum on the withdrawal of Great Britain from the European Union. False data related to multi-million funds, which British taxpayers were to transfer to the EU budget (Niklewicz, 2017), was used in the campaign concerning the so-called Brexit. Such news, although unconfirmed, triggered intense emotions among the UK citizens and, according to experts, this could have had an impact on the result of the vote (Balcewicz, 2021). For example, posting information on a popular website about the company’s withdrawal from the market, changing customer service policy or poor product quality (naturally untrue) may at any time cause a spectacular crisis and effectively destroy the company’s reputation. The reach of this type of content is usually very wide (Nowymarketing, 2021).

When considering fake news, one cannot forget about the motives of their authors. Literature reports that the production of fake news is based on two main motivations, i.e. financial and ideological goals (Edson et al., 2018). In 2017, as much as two-thirds of online disinformation in the US was disseminated for profit or political gain (Szulc, 2020).

Fake news is the real scourge of our time. Its dissemination and spread are enabled primarily through the internet, which allows each user to publish various content. Paradoxically, despite the general access to the internet and the possibility to independently verify the content of many messages, as recipients, we very easily succumb to fake news (Noizer.pl, 2021).

Speaking of information and its dissemination in the conditions of contemporary global, virtually unlimited communication, it should be noted that the excessive diversity of views on the internet may lead to the creation of like-minded users of the so-called “information bubbles” where internet users will be deprived of the opportunity to get acquainted with other perspectives of the described phenomena (Allcott et al., 2017). The overrepresentation of a certain type of information in the media may induce the observer to overestimate a potential threat, e.g. caused by the wave of refugees, underestimate the risk of promoting access to weapons or minimize the risk of using certain psychoactive substances (Szulc, 2020).

Fake news is neither true nor a lie because although it is based on disinformation, it often contains some elements of truth. It is created and used wherever and whenever the aim of the media publication is the greatest possible interest in the subject and not its compliance with the facts (Gillin, 2017). The internet is so eagerly used as a medium to spread fake news because with more and more content and information, it is

impossible to reach the primary source (Bąkowicz, 2020). The factor that is conducive to posting and spreading fake news is the phenomenon of post-truth that is present in social life and in the media, i.e. circumstances in which objective facts have less impact on shaping public opinion than referring to emotions and personal beliefs (Kawka, 2019). As a result of the increasing amount of information, the boundaries between fact and opinion are blurred as a result of us being unable to reach or discover the truth. Words in the public space have started to live their own lives so much that the meaning of the phenomena they describe or the context of their origin is frequently distorted. Denying the information does not cause its disappearance from the media, but it even revives its creation. One may be under the impression that no one cares about the truth as such, but all people care about is evoking emotions. And when emotions come to the fore, facts will always be considered secondary (Bąkowicz, 2020). In the media, post-truth is the society's consent to create information substitute, which is not always consistent with reality (Waszak, 2017).

When discussing the issue of fake news, deepfake technology should also be mentioned in this context. It will allow anyone to create "hyper-realistic" video material in which, for example, the images of politicians or celebrities will be used (without their knowledge or consent) to promote the ideas they would never express in real life or present facts that would never have happened (Westerlund, 2019). Today this technology, which operates based on deep learning algorithms and artificial intelligence, requires relatively high computing power. However, considering the fast pace of technological progress, one may expect that very soon such solutions will be widely available (Szulc, 2020).

Considering the situation in our country – nearly half of Poles have encountered the so-called fake news, i.e. false information disseminated on the internet. At the same time, 1 in 7 respondents admits that they have unconsciously duplicated fake news. The phenomenon of fake news is becoming more common and has largely entered not only the private sphere but also the business area (Signs.pl, 2021).

The international report of the GLOBSEC Policy Institute shows that the most active entities on the internet in Poland spreading fake news at present are external disinformation entities whose aim is to spread pro-Russian, anti-Ukrainian and anti-establishment propaganda (Szulc, 2020).

The issues related to perceiving fake news as barriers to the transmission of information and recipients' awareness of their impact will be presented in the subsequent sections of the article.

3. Methodology of the Conducted Research

Based on the author's previous experience related to surveying selected student groups, in order to achieve the adopted research goal, the survey

questionnaires were distributed using the CAWI (Computer Associated Web Interview) method in the period from 26 October to 5 November 2020.

The adopted approach consisted of the following stages:

- justification of the method of selecting the sample for pilot and main research and informing respondents about the possibility of completing the survey,
- constructing a prototype of a survey concerning the place and role of fake news in the communication process,
- substantive verification of survey questions on a randomly selected pilot sample of students,
- preparing the final form of a quantitative and qualitative survey, testing it and placing it on the servers of the Faculty of Management at the University of Warsaw,
- conducting surveys among randomly selected student groups as well as the analysis and discussion of the results,
- drawing conclusions from the obtained results.

The final version of the survey questionnaire consisted of the following parts:

- fake news features,
- the impact of fake news,
- the perception of received messages as potentially fake news,
- recipients' reaction to fake news,
- publishing or posting fake news.

The method of selecting the test sample was a case of random selection – the first 20 people were selected from those responding to the request to verify the research questionnaire. After introducing changes to the questionnaire, the final research sample was randomly selected from among all student groups that participated in the courses on Project Management and Computer Management Systems. Thus, the selection of the sample was a case of purposeful sampling, determined partially by the random selection of the pilot group and computer laboratory groups. The research was of a preliminary nature and it will be repeated in order to confirm the obtained results and draw more detailed conclusions.

The questionnaire was sent to 353 individuals, of whom 224 respondents filled it correctly and completely. This constitutes nearly 63% of the population who received the invitation to complete the questionnaire. The survey was conducted, as already mentioned, at the turn of October and November 2020.

Among the students who completed the questionnaires correctly, there were 64% of women and 37% of men, which is consistent with the gender structure of students in management studies in Poland. The random selection of student groups meant that most students (66%) attended the second year

of bachelor's studies, 18% were first-year students, and 16% of the sample were students of master's studies. For this reason, the average age of the population was established at 22, with 84% of students in the 18–25 age group, 14% were aged 26–30, and the remaining 2% were respondents representing other age groups. The random nature of the selection of student groups resulted in the fact that most survey participants (59%) had the status of a working student (mainly in the case of part-time studies). The largest share of the sample (43%) came from cities with more than 500,000 inhabitants and 21% came from cities with fewer than 50,000 residents. The smallest share in the study were rural residents (7%) and urban residents from cities with 100–500,000 inhabitants (9%).

4. Analysis and Discussion of the Obtained Results

The final form of the questionnaire, distributed electronically, contained twenty-four substantive questions as well as demographical data concerning the respondents' characteristics. The questions were divided into several groups. Due to the fact that the scope of the entire survey was wider than the scope of this article, the findings relevant to the present analysis will be presented below.

In the first part of the survey, respondents were asked about the characteristic features of fake news. In this group, two questions deserve particular attention. The first question focused on the issue of whether fake news can turn into „truth” and be perceived as such by the recipients of the information. The available options that the survey participants had to choose from were: „definitely yes”, „rather yes”, „rather no”, „definitely no” and „it's hard to say”. 89% of the answers to this question were affirmative, 7% indicated opposite opinions. The percentage of respondents who were not able to give a decisive response was estimated at 4%. The next question concerned the characteristics of fake news, comparing it to a „peculiar” internet virus. The available response options were the same as in the previous question. In this case, the respondents definitely agreed with the statement. An affirmative response („definitely yes” and „rather yes”) was given by 91% of the respondents, the opposite opinion („definitely not” and „rather not”) was expressed by 7% of the survey participants, and only a 2% share of the sample remained undecided. The results obtained in this section show that the respondents are aware of the existence of fake news and its „viral” nature in contemporary communication.

In the second group of questions concerning the impact of fake news presented to the respondents, there were three questions. The respondents' answers are shown in the table and the figure presented below.

Questions	Percentage of the responses				
	definitely		rather		hard to say
	yes	no	yes	no	
Can fake news be used as a competitive tool, e.g. to discredit competitors' services or products?	61%	3%	33%	1%	2%
Can fake news affect the shaping of the economic situation in the country, e.g. the tendency to give up certain services presented as risky?	42%	4%	50%	0%	4%
Can fake news influence the shaping of the political situation in the country, e.g. the tendency to vote for a particular party in elections?	65%	0%	33%	1%	1%

Tab. 1. Questions concerning the impact of fake news. Source: Own work.

Analyzing the results presented in the table above, it can be concluded that the respondents are aware that fake news exerts significant influence on its recipients and that it can be used to influence the formation of specific attitudes and behaviors among people.

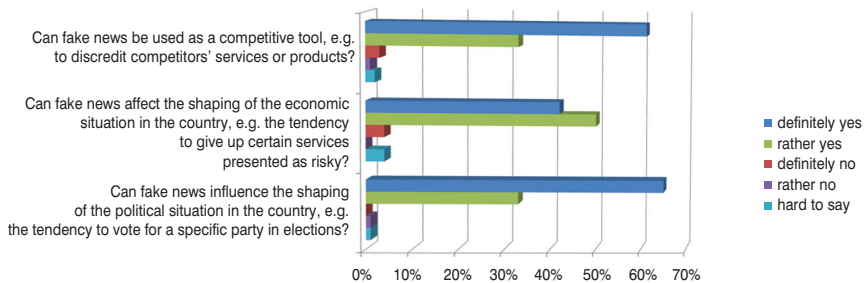


Fig. 1. Questions concerning the impact of fake news with the share of responses. Source: Own work.

It should be noted that the percentage of affirmative answers to all questions exceeded 90%, while in two cases none of the respondents gave a negative answer. These results confirm the awareness expressed in the previous set of questions related to the idea that fake news may „turn into” truth and function as such in the information flow.

The next group of questions was devoted to the evaluation of fake news. The set included five questions. The first question from this group concerned

the motivation behind the creation of fake news. The respondents were asked to state whether they agreed with the presented premise (yes) or thought that it did not occur (no). In the questionnaire, the survey participants also had the opportunity to provide another reason or motivation which might be important or relevant in their opinion. However, none of the respondents used this option. The results are presented in the table and the figure below (Table 2 and Figure 2).

Premises for creating fake news	Percentage of responses	
	yes	no
causing a sensation and triggering discussion on a specific topic	85%	15%
creating disinformation and confusion	70%	30%
achieving a specific goal, e.g. causing a specific behavior of recipients	88%	12%
increasing the click-through rate and a number of visits to certain websites	79%	21%
for the author's own satisfaction in order to "prove himself"	32%	68%

Tab. 2. Motivations behind the preparation of fake news. Source: Own work.

Referring to the results presented in the table above, it can be stated that, in the opinion of respondents who are recipients of information, the main reasons for the authors of fake news are: achieving a specific goal, e.g. triggering a specific behavior of recipients (88%) and the desire to cause sensation and initiate a discussion on a specific topic (85%).

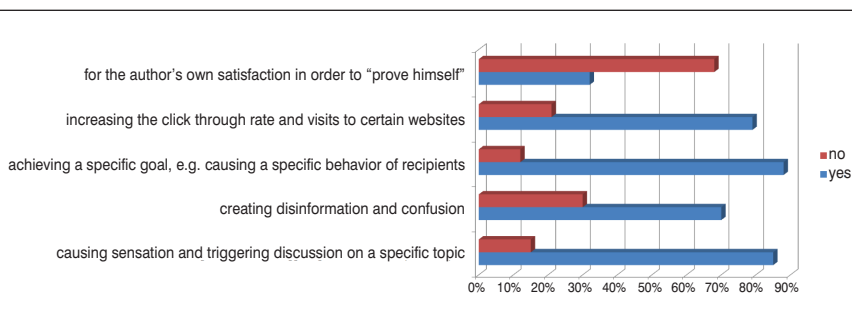


Fig. 2. Motivations behind preparing fake news with the share of responses. Source: Own work.

These results correspond well with the findings obtained in the first group of questions, where the respondents expressed the opinion that fake news can have a significant impact on the recipients. The respondents also did not share the view that the motivation for preparing fake news is

the ambition of their authors. This section also contained other questions, the details of which, together with the answers provided, are presented in Table 3 and Figure 3.

Questions	Percentage of responses				
	definitely		rather		hard to say
	yes	no	yes	no	
When you read specific information on the internet, hear it on the radio or watch it on TV, do you admit the possibility that it may be fake news?	27%	0%	56%	13%	4%
Does the huge amount of information provided by the media and the resulting "information noise" allow you to easily catch fake news?	4%	9%	28%	41%	18%
Can fake news be used in a political fight?	49%	4%	34%	6%	7%
Can fake news be a tool for instigating hate on the internet?	54%	0%	38%	2%	6%

Tab. 3. Questions concerning the evaluation of fake news. Source: Own work.

Summarizing the results presented in Table 3, it can be stated that the respondents realize that the information that reaches them may be fake news (80%), as well as a manifestation of hatred (92%) and a tool of political struggle (84%).

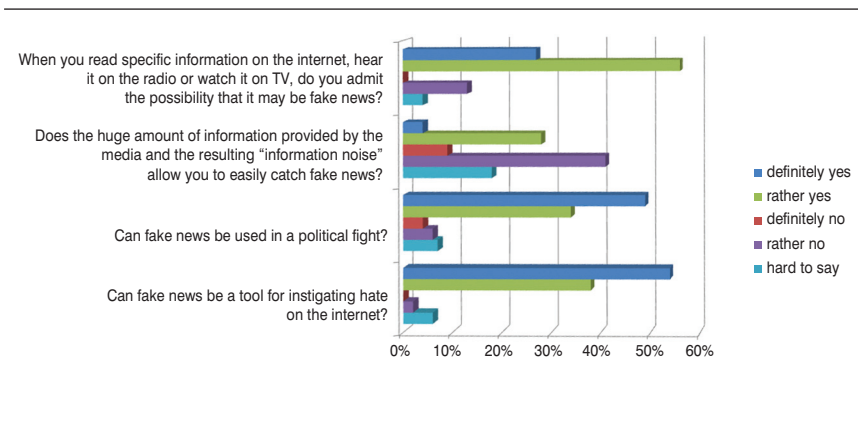


Fig. 3. Questions concerning the evaluation of fake news with the shares of responses. Source: Own work.

Despite the high awareness of recipients concerning fake news, it may be difficult to quickly detect it. 50% of respondents have doubts about it, which together with 18% of indications „hard to say” may justify the conclusion that discovering these types of messages quickly may not be easy.

The next set of questions in the surveyed questionnaire concerned the respondents' reactions to messages which, in their opinion, may be or are fake news. In this group, three questions were significant for the substantive scope of the study presented in this article. The relevant questions are presented and discussed below.

The first question was very important with regard to the reception of information. The question examined whether the respondents check the information they encounter and which they find „strange” or „improbable”. The answer options that the respondents could provide were „yes” or „no”. 88% of the respondents gave a positive response, 12% provided negative answers. Another question referring to the previous one concerned the field in which the information was most often verified by the respondents in terms of its truthfulness. Details are presented in Table 4 and Figure 4 below.

Information	Percentage of responses	
	yes	no
politics	67%	33%
economy	59%	41%
economics	50%	50%
sport	28%	72%
social affairs	74%	26%

Tab. 4. The area where the information is most often verified in terms of its truthfulness or accuracy. Source: Own work.

The field where the respondents most frequently verify the news in terms of its truthfulness or accuracy is social issues (74% of the respondents do so). They are the least suspicious when it comes to sports news.

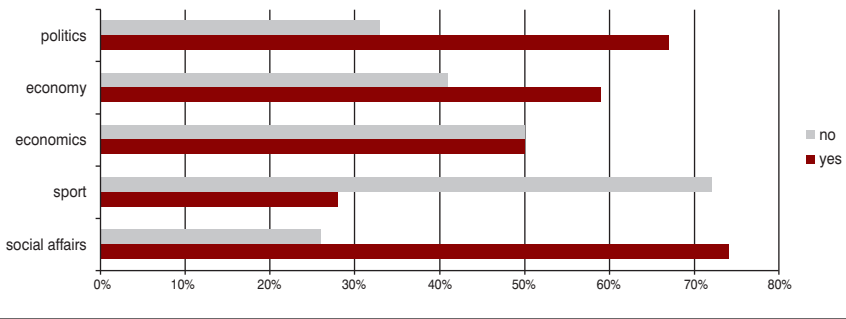


Fig. 4. Questions concerning the evaluation of fake news with the share of responses. Source: Own work.

An interesting result was obtained in the case of news concerning the area of economics, where the answers were divided equally (50% each). A high score in the category of social affairs may be the result of the prevailing pandemic and many changes taking place in this area (e.g. restrictions and limitations imposed by the government): the recipients want to be sure that the information they have is verified.

The third question in this group concerned the response to information that will be identified as fake news. The question was related to the situation when respondents consider the information to be fake news, and whether they are able to ignore it and do nothing. In the case of this question, 91% of answers were positive, compared to only 9% of negative responses. This demonstrates the readiness to ignore information that is deemed untrue, which is undoubtedly related to the awareness of the harmful effects of such messages on the recipients, expressed in the previous questions. When analyzing this question, it is necessary to bear in mind that in the conditions of the aforementioned post-truth, when the news relates to the scope related to specific beliefs based on emotions, the identification of fake news may be difficult or even impossible.

The last group of questions that were included in the survey questionnaire were ones concerning the publication of fake news in the media – most often on websites and social networks. This section of the survey focused on users' opinions regarding the activities limiting the impact of fake news as a barrier to communication.

Questions included in this group which were relevant to this study are included in Table 5 and Figure 5.

Questions	Percentage of responses				
	definitely		rather		hard to say
	yes	no	yes	no	
Can a subjective sense of anonymity on the internet favor or encourage publishing false content?	60%	0%	34%	3%	3%
Do large internet portals and social networking sites verify the published content in terms of its truthfulness?	9%	5%	19%	16%	51%
Does the available option of commenting on content posted on the internet allow publishing fake news?	37%	0%	48%	9%	6%
Should the users' identity be verified/ confirmed when publishing certain content on internet portals or elsewhere on the web?	17%	3%	46%	18%	16%
Should a system for reporting fake news be created, and by the same token, should some censorship of published content be introduced?	26%	6%	36%	15%	17%
Should there be a formal mechanism of pursuing, punishing, prosecuting etc. individuals, for the preparation, publication or dissemination of "fake news"?	18%	4%	33%	16%	29%

Tab. 5. Questions concerning publishing fake news in the media. Source: Own work.

Summarizing the obtained results presented above, it can be stated that the vast majority of respondents (94%) believe that the subjective sense of anonymity created by the internet affects the publication of false content. In this respect, the number of people disagreeing with the statement or not having a dissenting opinion is the lowest and in both cases, it amounts to only 3%. Similarly, many respondents believe that the possibility of commenting on the content offered by portals and websites provides an opportunity to publish false information (85%).

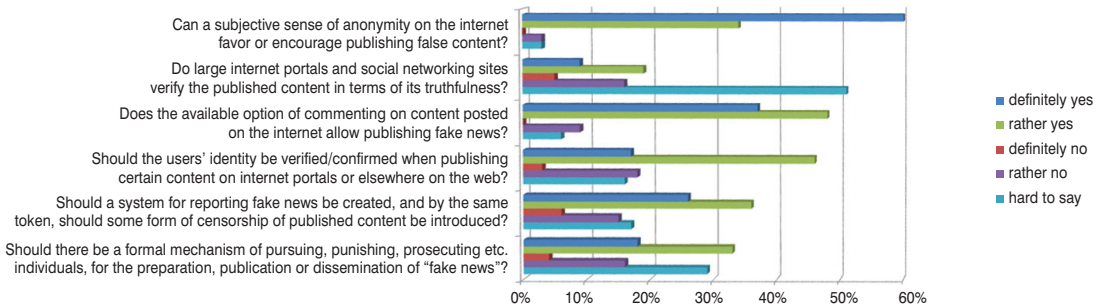


Fig. 5. Questions concerning publishing fake news in the media with the share of responses. Source: Own work.

Interesting results were obtained in response to the question of whether the content published on portals and websites is verified by them. More than half of respondents (51% of indications) are not able to determine whether such activities are undertaken, while only 24% of respondents believe that portals and websites verify the content which is published there. Regarding the introduction of a system for reporting fake news and possible punishment of its authors, the majority of respondents are of the opinion that such actions would be beneficial, but they do not declare it in a unanimous fashion (62% and 51% of responses, respectively).

5. Conclusions and Directions for Further Research

The results of the primary research carried out in the form of a survey questionnaire presented above allow the author to formulate the following conclusions¹:

- Media users, mainly internet users, as recipients of information:
 - are aware that the information that reaches them may be fake news and that such information constitutes a significant barrier in the communication process,
 - having knowledge of the existence of such false information, verify messages that seem “suspicious” to them,
 - notice that portals and websites do not sufficiently control the published content in terms of its truthfulness,
 - are not unequivocally convinced of the necessity to introduce mechanisms forcing the control of published information and thus ensuring a higher degree of its truthfulness.

- Inherently false messages may turn into truth (be perceived like that) and generally function as such in the information space.
- Information, including fake news, may shape the attitudes and behaviors of recipients.
- Interest in a specific topic is based on emotions.
- The evaluation and identification of fake news are difficult, and sometimes even impossible:
 - due to a large amount of information provided and the information noise in the media,
 - in the conditions of the so-called post-truth, i.e. when users search for and receive messages based on their own beliefs and emotions, and objective facts are considered to be of secondary importance.
- Fake news messages are prepared with the intention of triggering a specific reaction desired by the author.
- The internet, currently the most popular information medium, offering a subjective sense of anonymity, creates an opportunity to publish fake news.

In summary, one can formulate a final conclusion that fake news, containing inherently false information, constitute a significant barrier in the communication process. Due to the previously indicated limitations of the study, the findings cannot be generalized and extended to a larger population. However, the study can constitute the starting point for further research endeavors. Moreover, bearing in mind that this is a very important issue as regards the proper functioning of the information process, research in this area will be continued. Such research will be extended to include other age, professional and social groups. Modifications will also apply to the list of questions contained in the questionnaire form, as well as their scope. However, the number of questions (30) will not be increased. The author intends to expand the geographic area covered by the study with the cooperation of other academic centers. Subsequent research into the issue may bring interesting results that would allow for a better understanding of the analyzed phenomenon, while the resulting publications will enrich the literature on the subject.

Acknowledgements

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Endnotes

- ¹ Due to the limitations described above, the study results cannot be generalized to a larger population. On the other hand, being pilot studies, they constitute the starting point for further research in the analyzed area.

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Integrated ERP-Class Management Information Systems – Evolution, Current State and Development Directions

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Abstract

Purpose: The aim of the article is to present the evolution of ERP systems and to identify the most important directions of ERP systems development.

Design/methodology/approach: The paper uses the classical literature analysis method that consists in identifying the state of the research along with a critical reflection on it (critical literature review). Based on the analysis of the literature as well as the results of reports on ERP systems, suggestions for further development of ERP systems were formulated.

Findings: The dynamic development of technology, increased competition in the IT market and changing needs of enterprises will result in the evolution of ERP systems. The article shows the directions of development of ERP systems (verticalization of ERP systems, cloud ERP, mobility, internal and external integration of ERP systems, automation in ERP systems, multimedia ERP systems, process ERP systems, minimizing the implementation time of ERP systems, increased popularity of Open Source ERP systems).

Research limitations/implications: The pace and scale of technological change is altering almost every area of enterprise activity. It is difficult to unambiguously assess which of the changes in the IT area will have the greatest impact on the evolution of ERP systems. Directions of ERP systems development indicated in the article are only possible proposals of changes.

Originality/value: The directions of development of ERP systems outlined in the article may constitute a premise for a discussion on their further evolution in the digital economy.

Keywords: ERP, integrated management information systems, evolution

JEL: M1, M15

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Zintegrowane systemy informatyczne zarządzania klasy ERP – ewolucja, stan obecny i kierunki rozwoju

Streszczenie

Cel: przedstawienie ewolucji systemów ERP oraz wskazanie najważniejszych kierunków rozwoju systemów ERP.

Metodologia: w pracy wykorzystano klasyczną metodę analizy literatury polegającą na identyfikacji stanu badań wraz z krytyczną refleksją nad nim (krytyczny przegląd literatury). Na podstawie analizy literatury, a także wyników raportów dotyczących systemów ERP – sformułowano sugestie dotyczące dalszego rozwoju systemów ERP.

Wyniki: dynamiczny rozwój technologii, wzrost konkurencji na rynku IT oraz zmieniające się potrzeby przedsiębiorstw będą skutkowały ewolucją systemów ERP. W artykule wskazano kierunki rozwoju systemów ERP (wertykalizacja systemów ERP, cloud ERP, mobilność, integracja wewnętrzna i zewnętrzna systemów ERP, automatyzacja w systemach ERP, multimedialne systemy ERP, procesowe systemy ERP, minimalizacja czasu wdrożenia systemów ERP, wzrost popularności systemów ERP typu open source).

Ograniczenia/implikacje badawcze: tempo i skala zmian technologicznych zmienia niemal każdy obszar aktywności przedsiębiorstw. Trudno jednoznacznie ocenić, które ze zmian w obszarze IT będą miały największy wpływ na ewolucję systemów ERP. Zasygnalizowane w artykule kierunki rozwoju systemów ERP są jedynie możliwymi propozycjami zmian.

Oryginalność/wartość: nakreślone w artykule kierunki rozwoju systemów ERP mogą stanowić przesłankę do dyskusji na temat ich dalszej ewolucji w gospodarce cyfrowej.

Słowa kluczowe: systemy ERP, zintegrowane systemy informatyczne zarządzania, ewolucja systemów ERP.

1. Introduction

Supporting enterprise management and streamlining business processes can be achieved through the use of various IT tools and measures, including primarily integrated ERP (Enterprise Resource Planning) IT management systems. Nowadays, ERP-class IT systems are used in various enterprises, different in terms of size, industry, nature of activity or forms of ownership. The considerable functional scope of ERP systems enables IT support in almost all fields of an enterprise's activity. The digital transformation of many enterprises means that the ERP system plays a key role in the strategies of many of them.

Originally, i.e. in the 1960s, ERP systems, mainly due to their functional scope, technological advancement and high level of costs, were dedicated to larger companies with a production profile. Scientific and technological progress resulted in the further development of ERP systems, and the competition on the IT market contributed to the popularization of ERP systems, which resulted in them being within the reach of smaller organizations not only of a production nature, but also conducting commercial or service activities. Currently, there are many trends and directions for the development of ERP systems. The COVID-19 pandemic has created new

challenges for ERP systems related primarily to the expansion of remote work of employees and the provision of collaboration and communication between remote employees and other employees and business partners. ERP systems are at the heart of digital transformation, and more complete integration of processes, data, and documents enables real-time decision-making, faster communication and collaboration, increasing employee productivity and reducing resource consumption. The aim of the article is to present the evolution of ERP systems and to identify the most important directions of ERP systems development. To achieve the aim of the article, the characteristics of ERP systems were briefly presented and the picture of the ERP systems market in Poland and in the world was outlined.

2. The Concept, Features and Classification of ERP Systems

Nowadays, integrated management information systems of ERP class are becoming an important tool influencing the improvement of management processes and improvement of the company's results (Gospodarek, 2015; Auksztol et al., 2011; Parys, 2012). ERP systems are implemented and used in various types of enterprises, varying in terms of industry, size, form of ownership or scope of operation. In 1990, Gartner Group coined the acronym ERP for Enterprise Resource Planning: "the system that integrates across and between functions" (Hurbean & Footahe, 2014). According to E. Turban and others, an ERP system is a set of IT tools that allows you to manage the resources of an organization and control the ongoing business processes in real time (Turban et al., 2007). According to A. Bytniewski and others, the integrated IT management system covers all areas of management in the enterprise and in the immediate environment, and is characterized by a common database, computational procedures and performs info-control activities to optimize business processes through the use of information and communication (IT) technologies (Bytniewski et al., 2018). According to C. Brown and others, an ERP system is a set of integrated business applications, or modules, that carry out common business functions such as general ledger accounting, accounts payable, accounts receivable, material requirements planning, order management, inventory control, and human resources management (Brown et al., 2019). According to H. Beheshti and others, ERP systems link all areas of a service company, including financial systems, stock management, order management, human resources and stock distribution to customers and external suppliers into an efficient integrated system with real-time data available to users (Beheshti et al., 2014). Therefore, ERP systems should be understood as a modular (or component) organized IT system that supports most or all spheres of an organization's activity, whose task is to support management processes. The most important features of ERP systems are listed in Table 1.

Main features of ERP systems	
Feature	Feature description
Functional complexity	It consists in covering all spheres of the company's technical and economic activity.
Modular/component construction	It enables the phased implementation of the ERP system and the implementation of only those of its areas that are necessary due to the nature of the company and the specificity of its activity.
Substantive advancement	It manifests itself in the support of information and decision-making processes and the incorporation of free data extraction mechanisms, variants, optimization and forecasting, as well as the possibility of using management methods such as TQM (Total Quality Management) or JiT (Just In Time) in ERP systems.
Technological advancement	It guarantees the compliance of the ERP system with the current hardware and software standards and enables further development of the system. It guarantees the compliance of the ERP system with the current hardware and software standards and enables further development of the system.
High degree of integration	A significant degree of integration of procedures and data both inside individual modules and in inter-module connections (e.g. electronic data interchange – EDI).
Process orientation	It means preparing the system for comprehensive information service of individual economic processes, and not individual elements of the company's organizational structure.
Functional and structural flexibility	The possibility of adapting IT solutions to the needs of the enterprise and the possibility of increasing its functional scope and its operating parameters along with the growth of the needs and requirements of the user.
Openness	It manifests itself in the scalable architecture and the possibility of expanding the system with new modules and connecting with external systems.
Considerable independence from the hardware platform	The ability to run an ERP system on different computers and servers, equipped with different operating systems.
Safety	The use of proven and safe hardware and software solutions, including database systems, guarantees high reliability and security of resources and user work, while protecting the company's IT investments.
Compliance with regulations	The ERP system complies with the law and rules in force in a given country (e.g. with the Accounting Act).

Tab. 1. The most important features of ERP systems. Source: Own study based on Gunia (2020), Banaszek et al. (2016).

Integrated IT management systems of ERP class are gradually replacing single-domain and unrelated IT systems used in enterprises. ERP systems, through comprehensive support for the basic areas of business operations, ensure the consistency of business processes and enable the generation of cross-sectional reports, which in turn translates into the effectiveness of decisions made at various levels of management. Generally, ERP systems help, among others, optimize data flow and integrate it, reduce the impact of the prevailing information noise, identify the weaknesses of the enterprise and emerging opportunities faster (Olszewska, 2007). According to T. Parys, the integration of individual modules in ERP systems consists, among others, in the flow of data generated throughout the enterprise (by individual modules) to the financial module, which affects the ability to quickly obtain financial statements used in strategic areas of the company's operations (Parys, 2006a). ERP systems enable the implementation of modern organizational and structural forms of enterprises in which all data resources, management procedures, steering and regulation of business processes (both inside and outside the enterprise, i.e. together with partners) can be implemented with the support of information and communication.

From the point of view of technical solutions, an ERP system has the following properties (Gunia, 2020):

- the user using their own workstation is able to use any function of the system,
- within the entire ERP system, users use the same interface,
- data is entered into the system only once and automatically updates the system status and is visible to all its users.

According to J. Majewski, ERP systems fulfill several important functions, i.e. (see Majewski, 2008):

- initiating (preparation of documents and orders),
- planning (demand forecasting),
- control (verifying the obtained results with the expected customer service patterns),
- coordination (sales and material supply planning, production scheduling),
- integrating (by means of which it is possible to connect the company's system with external systems of recipients and suppliers).

Classification of ERP systems according to several selected criteria is presented in Table 2. To sum up, an ERP-class system, through the ability to define any statements/reports from the ERP system, provides managers with an easy way to access full information about the enterprise, and advanced analytical tools allow for detailed analyses of processes taking place in the enterprise, thanks to which one can control various areas of the enterprise's activity. The integrated IT system of ERP class enables users to remotely access the system (including connection with mobile devices). The ERP system supplier offers the possibility of implementing additional modules and new functionalities, and provides updated versions of the system that

contain legal changes, new patches to remove noticed errors, and increases security, etc.

Classification of ERP systems	
Type of classification	Type of classification and their description
By the way of installing / using the ERP system	<p><i>Stationary system</i> – installed on the selected server. Depending on its architecture, access to the system is possible through a dedicated client application (installed on a computer, phone, tablet or another device of the user) or a web browser.</p> <p><i>ERP as a service</i> – a very popular, very convenient model in which we use the ERP system like any website. The account for the system is made available by its producer after paying the subscription fee.</p>
By the construction of the ERP system	<p><i>Monolithic systems</i> – they have a uniform structure and the source of all their functions is in fact one application.</p> <p><i>Modular systems</i> – are a set of applications (accounting, warehousing, CRM, etc.), which, despite the fact that they have a consistent structure, graphic layer and that they share data, do not constitute one entity from the architectural point of view. Individual modules of ERP systems can often develop independently of the others, and also be activated only when necessary. Manufacturers of modular ERP systems usually make payments for their products dependent on the software modules we use.</p>
By the functionality of the ERP system	<p><i>Universal ERP systems</i> – designed in such a way as to serve the company regardless of the industry in which it operates. The basic functionality is usually broad, but quite general. Adapting to the specifics of a particular industry or company is usually (to some extent) possible through an appropriate system configuration.</p> <p><i>Industry-specific ERP systems</i> – tailored to a specific type of activity (e.g. energy production, telecommunications, banking, etc.), equipped with functions typical for a given business.</p> <p><i>Dedicated ERP systems</i> – created from scratch for the needs of a specific company.</p>
By the way the ERP system is implemented	<p><i>Box systems</i> – ready to work right after installation / logging in. Their use is based on the functionality provided by the manufacturer, so the implementation process is not time-consuming.</p> <p><i>Systems adapted to individual needs</i> – require in-depth pre-implementation analysis and implementation works, adjusting the base tool to the company's requirements.</p>

Tab. 2. Classification of ERP systems. Source: Based on Rawski (2019).

Originally, ERP systems were dedicated to large manufacturing companies (Dziembek, 2014). Basically, the development of ERP systems

from the 1960s started from MRP (Material Requirement Planning) systems, through MRP II (Manufacturing Resources Planning) production and distribution planning, to ERP (Enterprise Resource Planning) (Turek & Dziembek, 2018). Initially, the goal of the MRP concept was to solve the problems of material preparation of production. Integrated IT systems created on the basis of the MRP idea planned the amount of material stocks in order to ensure the optimal level of production in economic organizations. Furthermore, this system analyzed the stocks of material and determined their amount at such a level that their storage time was the shortest, while maintaining continuity of production. As a result, the overriding goal of the MRP system is to maximize the use of production capacity while minimizing the level of raw materials stocks. The next step was the Closed Loop MRP, which considered the planning of inventories and material deliveries in a closed-loop production process, and at a later stage of development a standard called MRP II was created. Compared to the original MRP, it was extended to include planning and control of other production factors (human, machine and money resources). As a result, the MRP II standard additionally included modules enabling production planning, business planning, inventory and supply management, demand and sales management. The American APICS association has made a precise description of the MRP and MRP II standards (and at the same time establishing and consolidating them).

The next stage in the development of integrated management information systems was the ERP standard, created in the 90s and in which the previous MRP and MRP II standards were fully integrated with virtually all spheres of the company's activity, i.e. accounting, finance, controlling, marketing, human resources management or project management with strategic management tools. The integration of all modules takes place without duplicating information, because the ERP system is based on a central database that collects and stores data from various areas of the company's operations. Data and information describing the company's operations are updated in real time and through reports or analyses can be easily made available (online) to decision-making managers. The processes of integrating all data collected in individual subsystems included in ERP enabled the processes of planning, simulating and correcting economic activities undertaken at various levels of management. At a later stage, ERP systems offered additional modules for Customer Relationship Management (CRM), project management, analytical tools (Business Intelligence) and Supply Chain Management. The wide functional scope of ERP systems has enabled their use also in enterprises that do not conduct production activities (e.g. trade, service), and even in public organizations.

Further development of functionality and flexibility as well as extending the scope of computerization of enterprises to new areas of activity resulted in the creation in 2000 of a new concept, defined by the consulting company

Gartner Group as ERP II. Gartner Group defines ERP II as a business strategy and a set of industry-domain-specific applications that build customer and shareholder value by enabling and optimizing enterprise and inter-enterprise, collaborative-operational and financial processes (Hurbean & Footahe, 2014). ERP II systems are to enable modern enterprises to adapt to changes taking place in the market environment, such as the deepening specialization of modern enterprises, the globalization of the economy and the need for economic cooperation with other entities for the benefit of a common client. The main assumption of the ERP II standard is openness and the possibility of cooperation with other IT systems of recipients, partners and suppliers of a given economic organization. According to T. Parys, the ERP II system is an integrated management system that enables planning and management of financial assets, as well as supporting contacts with the outside world (Parys, 2006b). The emergence of the ERP II concept could take place due to the dynamic development and popularization of network (internet) technologies, enabling relatively cheap electronic data flow between individual economic entities. The use of internet technologies enabled the exchange of data between the systems of business partners, reducing costs, increasing the effectiveness and efficiency of cooperation and optimizing jointly implemented economic processes. ERP II systems enable the creation of distributed organizations that transform from vertically integrated and focused on optimizing the functioning of their core areas of activity towards flexible, focused on their basic skills and cooperating within the value network of enterprises. The differences between ERP and ERP II systems are shown in Figure 1.

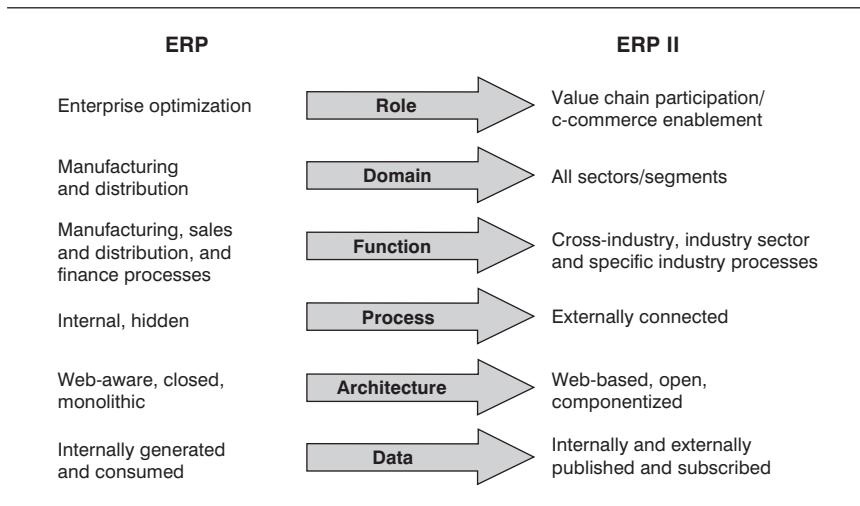


Fig. 1. Differences between ERP and ERP II systems. Source: Hofmann (2008).

The structure of ERP II systems includes a group of autonomous components based on internet technologies that can be combined with each other and which, through the use of XML language, can be shared with other entities. Therefore, in ERP II systems, full integration with such systems as: CRM (Customer Relationship Management), SCM (Supply Chain Management), WM (Workflow Management) and BI (Business Intelligence) takes place. In addition, ERP II systems include the use of e-procurement systems (automation of processes in the field of equipment supply, office supplies and consumables, etc.) and deeper cooperation with e-markets (making purchases in e-stores, e-exchanges, etc.). In addition, ERP II systems feature specialized modules to support Supplier Relationship Management (SRM), Product Life Management (PLM) and Strategic Enterprise Management (SEM). The Gartner Group assumed that ERP II systems would be adapted to four basic areas of business activity, i.e.:

- discrete production (production of durable material goods, e.g. cars, household appliances and TV, etc.),
- process production (production of less durable material goods, e.g. food products, chemicals and cosmetics, etc.),
- resource-intensive domain (mining, transport, telecommunications, etc.),
- service-intensive domain (consulting, financial, outsourcing services, etc.).

The effect of adopting such an optics of further development of ERP II systems is the specialization among ERP II system suppliers, who will be forced to present a coherent concept of ERP II system operation depending on the industry specificity of the enterprise, with the existing market conditions.

The next level of development was the ERP III (The Third Generation ERP) system, which included the functions and capabilities of ERP II systems increased by the possibility of active cooperation of the client in the implementation of the company's business processes, which is to ensure better products and faster implementation of changes and innovations. Mobile technologies used by both customers and employees of the enterprise play a key role in ERP III systems. An important element of this generation of ERP systems is their openness and construction in accordance with the SOA (Service Oriented Architecture), i.e. the concept of creating IT systems, in which the main emphasis is on defining services that will meet even the most sophisticated user requirements (Parys, 2018). These services will be individual applications that are system modules the task of which will be even greater integration of users (mainly customers with the organization). According to Wan and Clegg, ERP III is defined as a future virtual enterprise structure with a flexible, yet powerful information system incorporating web-based SOA and cloud computing version (Wan & Clegg, 2011). The system compliant with the ERP III concept also uses internet technologies (e.g. analytical search engines), social media, internet trading platforms and various on-line communication tools, which together make it

a solution enabling the operation of the enterprise according to the virtual model. ERP III systems also assume the use of Grid and Cloud Computing technologies. As J. Vasilev notes, usually ERP systems use a centralized DBMS (Data Base Management System). The use of GRID computing allows the DMBS to be separated and stored in several servers. The result is higher performance of end-user applications (Vasilev, 2013). In turn, B. Wood states that through collaboration, direct contact, social media, and various data streams, within and outside of the enterprise, ERP III integrates marketplace fans and critics into the existing ERP and ERP II organizations. From the integration of customers and vendors beyond the enterprise boundaries, a constructive dialog or information exchange is created to innovate, produce, and then sell (or distribute) better products or services (Wood, 2015). At present, suppliers of integrated systems do not define their systems as ERP III (usually qualifying their products as ERP II with additional capabilities). A presentation of the differences between ERP, ERP II and ERP III systems is shown in Figure 2.

Role	Enterprise optimization and integration	Value chain participation	Value network virtual value chain
Domain	Manufacturing and distribution	All sectors	Strategic alliances, network collaboration
Function	Manufacturing, sales and distribution, financials	Industry sector and cross-industry	Global industry sectors
Process	Internal, hidden	Externally connected, inter-enterprise relations	Open network to create borderless enterprise
Architecture	Web-aware, closed, monolithic	Web-based, open, componentized (EAI)	Cloud-based, Service Oriented (SOA)
Data	Internally generated and consumed	Internally and externally published and subscribed	Externally exchanged via cloud computing
	ERP I	ERP II	ERP III

Fig. 2. The differences between ERP, ERP II and ERP III systems. Source: Hurbean and Fotache (2014).

Nowadays, the standard of ERP/ERP II/ERP III-class systems, extended with BI (Business Intelligence) systems, is the basis for computerization of most enterprises. Therefore, ERP/BI-class systems are the most important examples of IT systems used to support management. Systems of this type

are complex and analytically developed systems that collect data on the basis of primary events within a common database, and then process them for analytical purposes and to support decision-making processes. An exemplary set of modules and functionalities included in the ERP system is shown in Figure 3.

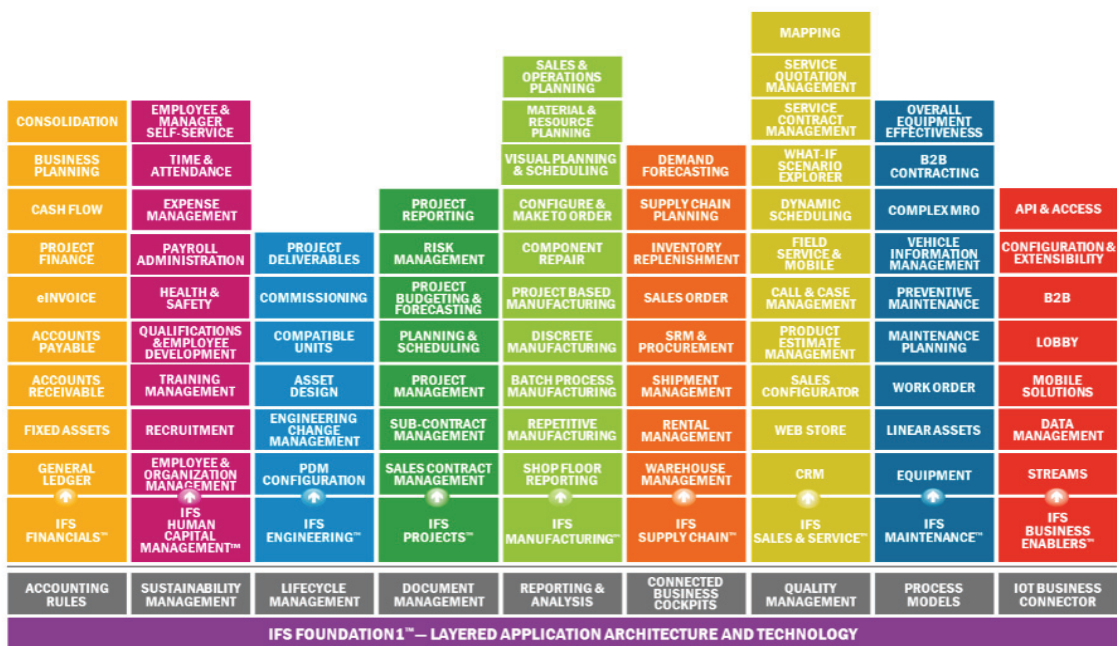


Fig. 3. Example of an extensive ERP system (IFS Applications). Source: <https://www.nec.com/en/global/solutions/ifs/>.

In recent years, regardless of commercial ERP systems, ERP systems in the Open Source formula have also been developed, which can be downloaded and installed free of charge, while implementation services and technical support are paid. The distinguishing feature of these systems, apart from the lack of license fees, is the possibility of significant modification and adaptation of the system to the company's needs. Despite the certain popularity of this type of systems, numerous and deep legal changes and a small group of entities offering implementation services of this class of systems may discourage enterprises from using ERP systems in the Open Source formula.

3. The Market of ERP Systems in Poland and in the World

Currently, the market of integrated ERP systems is one of the fastest growing in the IT industry. The ERP systems market in Poland in 2018 was worth approximately USD 217.3 million. According to forecasts, the ERP market in Poland in 2021 will amount to approximately USD 242.2 million – therefore, expenditure on ERP systems in Poland will increase by over 17% (Statista, 2019). According to the ERP24.pl portal, the DiS research company estimates that over 28 thousand companies use ERP systems in Poland. The number of users of these solutions is 600 thousand and in 2020 it will increase to 700 thousand (ERP24.PL, 2016). Additionally, according to the AMR company, the value of the global ERP market will reach PLN 78.4 billion by 2026, with a CAGR of 10.2% from 2019 to 2026 (Raport ERP Perspektywy, 2020).

According to data from the Central Statistical Office (CSO, pl. *GUS*) of Poland for 2019, 28.5% of enterprises declared the use of ERP systems among all enterprises employing at least 10 employees. Compared to 2017, there was a slight increase of 2.4 percentage points. The result below 30% puts Poland in the sixth place from the bottom among countries in the European Union in terms of having ERP systems (ITWIZ, 2019). According to the quoted CSO research for 2019, large organizations (250 or more employees) are the leaders in the use of ERP solutions, of which 87.3% have implemented ERP systems. Also less than 54% of medium-sized companies (at least 50 employees) use ERP systems. Currently, in Poland, ERP-class IT systems are chosen not only by large and medium-sized enterprises, but also by smaller economic entities, which have noticed the value and facilitation of work in ERP systems through the possibility of accessing information about resources (financial, material or personal) in one place and the state of the company's ongoing processes. However, ERP systems are used by only slightly more than 21% of small enterprises (employing 10 to 49 employees), as shown in Figure 4.

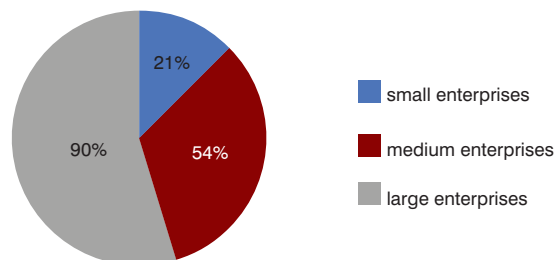


Fig. 4. The use of ERP systems in Polish enterprises, broken down by size. Source: Central Statistical Office of Poland, 2019.

ERP systems in Poland are most often used in enterprises specializing in information and communication, generation and transmission of electricity, gas and water. The least frequently ERP systems are used in industries such as construction, retail, transport and warehouse management, and the clothing industry. These analyses show how big still is the growth potential of the ERP systems market in Poland (especially in the sector of small and medium enterprises). Among other things, the growing number of information obligations of enterprises towards public organizations will probably result in an increase in the implementation of ERP systems in Poland.

According to Eurostat data published in 2019, the average for all enterprises using ERP and operating in one of the EU countries was 34%. Belgium was the clear leader, where as many as 53% of enterprises used the ERP system. Denmark came second with a 50% share. The third place was taken by France, Lithuania and the Netherlands with 48% of companies using ERP. Behind Poland (29%), apart from countries such as Ireland, Croatia, Estonia, Romania, Bulgaria and Hungary, was also the United Kingdom, where, according to Eurostat data, only 24% of enterprises used ERP. The presentation of the use of ERP systems in enterprises from the EU is presented in Figure 5.

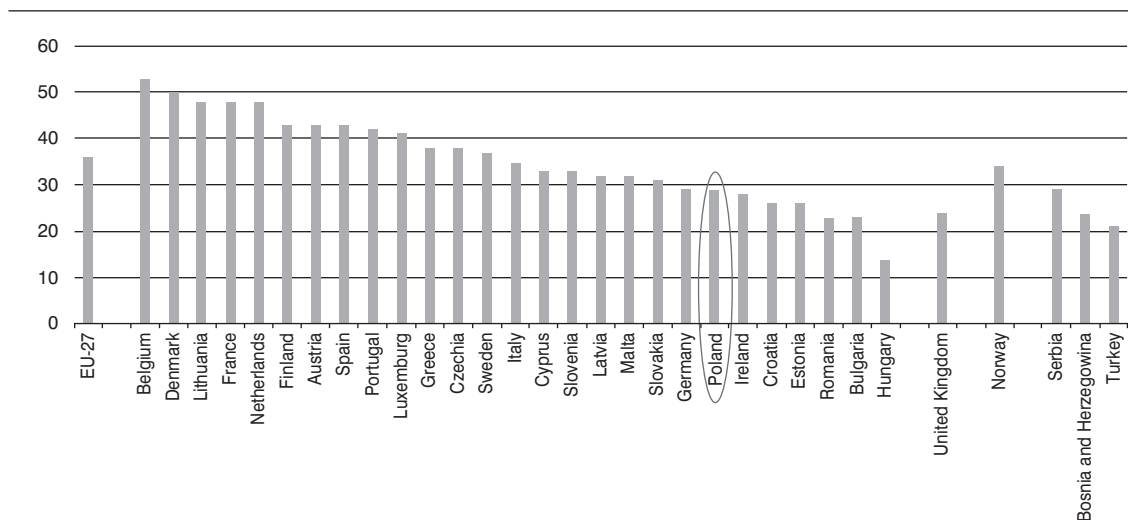


Fig. 5. The scale of application of ERP systems in enterprises in the EU. Source: Eurostat, 2019.

In the world, one of the largest suppliers of ERP systems are: SAP, Oracle, Sage, Infor, Microsoft, Kronos, Totvs, YonYou, Unit4. On the Polish market, ERP system suppliers with the largest market share include: SAP, Comarch, Oracle, IFS, BPSC. Other major providers of ERP systems on the Polish market include: Microsoft, Sage, enova, Exact, CleAR, InsERT, Asseco, Epicor, ODL, PC Guard, Sente, Simple, Streamsoft, Infor, Unit4 TETA and others. Currently, the market of ERP systems in Poland is characterized by a certain maturity, mainly due to the fact that there is a significant number of domestic and foreign ERP system suppliers competing for customers. Such a situation causes changes in the systematic cost reduction, improvement of the quality and functionality of solutions as well as consulting and better handling of support during the use of ERP systems, beneficial for enterprises. Providers of ERP systems, as part of a better proposal for recipients, develop their products (new functions and possibilities adapted to changes in the organization and functioning of enterprises, e.g. the possibility of cooperation with other contractors as part of jointly implemented processes, changes in law, etc.) and more and more often they offer the model purchase and use of an ERP system in cloud computing. The tendency to lower the cost of implementation, including the dynamic development of IT services (e.g. Cloud Computing), resulted in the fact that due to the ever lower costs of implementing ERP systems, more and more smaller enterprises can also afford the purchase of an ERP system. According to a study by Panorama Consulting Group conducted among 112 companies from different parts of the world, Cloud ERP systems are now becoming more popular than ERP systems installed on the basis of their own IT infrastructure (on-premise), as shown in Figure 6. According to IDC estimates, in 2025, in Central and Eastern Europe, cloud computing will have a 69% share in the ERP market (Mejsner, 2017).

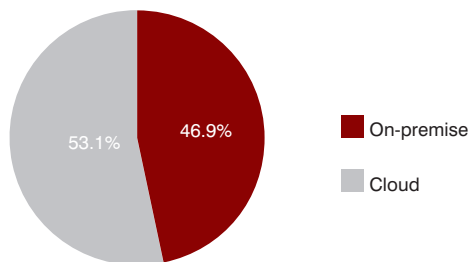


Fig. 6. Popularity of basic models of ERP systems implementation (Cloud ERP and ERP on-premise). Source: Panorama Consulting Group, 2020.

The speed of digital transformation of enterprises makes it necessary to shorten the long-term implementation (e.g. over a year) of ERP systems

and provide them with appropriate flexibility, i.e. rapid change of new functions or reorganization of the ERP system as a result of changes in the market environment. The market analysis also shows that there is a growing awareness among company managers that without ERP systems, the companies they manage will not be able to compete with other entities equipped with such solutions, thanks to which they can improve their processes and make decisions based on current, reliable and accurate data. In recent years, the risk of failure to implement the ERP system and failure to meet the expectations for this class of systems has also significantly decreased. Among the recipients, there are situations of replacing the existing ERP systems with other ones due to their insufficient potential to support the current management of the enterprise.

The coronavirus pandemic worsened the financial situation and market conditions of the functioning of enterprises in many industries. Many companies, wanting to stay on the market, accelerated their digital transformation and dynamically improved their ERP systems. The new challenges for ERP systems were related, among others, to the extension of remote work of employees, guaranteeing the smoothness of implemented processes and ensuring safe cooperation and communication of remote employees with other employees and economic partners (e.g. building or developing digital and flexible supply chains). In times of the pandemic, ERP systems, through deeper automation of business processes, can replace the work of staff to a greater extent, and allow the management to remotely (without the risk of direct contact) control all areas of the company's operations on an ongoing basis. ERP systems also allow for controlling the working time of remote personnel and maintain the required discipline and productivity among them. In addition, ERP systems can also facilitate the process of transferring business to virtual space by unifying and supporting the functioning of digital sales and purchasing platforms. As a result, the extensive and in-depth use of ERP systems allows not only for improving and automating business processes of the enterprise, increasing operational efficiency, but also for reducing the risk of infections by minimizing direct contacts between staff and between employees and customers or suppliers.

According to a study by KPMG International and Harvey Nash among IT leaders around the world, during the first wave of the COVID-19 pandemic, companies spent an additional \$ 15 billion more per week on technology to ensure their organizations' transition to remote work. As many as 86% of IT leaders who participated in the KPMG International and Harvey Nash survey introduced remote work for their employees, and 43% expect that after the pandemic more than half of their employees will work from home. About 50% of IT leaders in the world and 52% of IT leaders in Poland believe that the COVID-19 pandemic has accelerated digital transformation and the adoption of new technologies. Although the ERP system is the pillar of digital transformation, leaders of IT departments, when asked

about the key technological areas in which organizations invest, mainly mention: security and privacy (47%), customer experience and engagement management (44%), as well as infrastructure and cloud solutions (35%) (KPMG, 2020).

4. Directions of ERP Systems Development

ERP-class systems are an IT solution that has been shaped and evolved over the last few decades, constantly expanding the scope of support and integration of the company's areas. The development of ERP systems is not only dependent on the availability of technological solutions used at a given moment, but is a response to the current needs of a constantly changing market. ERP systems are evolving due to dynamic changes in the environment (including the development of competition, changing customer needs, development of connections, dependencies and processes implemented in the electronic economy), and the main directions of changes can be presented in several areas, i.e. (Eurobajt, 2019):

- system integration – ERP systems in the company collect data from many internal and external sources, which, after processing, should provide all and necessary information that is an important element of company management. In these circumstances, the development of ERP systems should focus on better system integration in such a way as to improve the connection with modern information technology, B2B (Business to Business) systems and new-generation devices that enable data reading;
- customization – there is a constant increase in ERP recipients serving various fields of activity. For this reason, enterprises require systems to have functions that drive the processes appropriate to their industry;
- migration to the cloud – trends in the business market show that more and more enterprises are starting to move their ERP systems to the cloud. Such a solution gives the company flexibility in collecting huge information resources, its implementation is easy, fast and safe, and what is more, it has low costs of starting and maintaining systems;
- mobile devices – according to many entrepreneurs, mobility of devices plays and will play an important role in the short term. Mobile tools allow constant access to data contained in the company's systems, regardless of the place and time of stay. Thanks to such solutions, ERP systems will be able to support not only internal communication, but also the external one (communication with distributors);
- the fourth industrial revolution – having ERP systems is certainly related to the idea of the Internet of Things (Intelligence of Things) and Industry 4.0. The new concepts assume connecting machines, systems, processes and products with each other in “intelligent” networks which, through self-control and information sent to them, will optimize the processes taking place in the enterprise. However, to get involved in

projects, companies will need ERP software that collects the necessary data from all areas of it.

An interesting proposal for the development of ERP systems was presented by E. Abramek et al., listing such trends as (Abramek et al., 2014):

- wide use of cloud technologies (Cloud Computing),
- making it possible to increase the efficiency of employees through the extensive use of mobility and the related BYOD trend,
- implementation of tools allowing for modeling and improving business processes,
- further development of data analytics (including data from social networks) and enabling the effective use of Big Data resources,
- creating the ability to access the system from the level of a web browser, regardless of the device used,
- increasing the ergonomics of ERP systems use, e.g. by creating graphical interfaces adapted to individual user roles or the so-called “dashboards” (interfaces that provide quick access to the most important data).

A proposal to present the further development direction for ERP-class systems is the concept of the ERP IV system (Bytniewski et al., 2018; Parys, 2018), which is expected to become popular from 2020 and its goal will be, among others, wide implementation of the mechanisms of globalization of economic activities and deeper integration of links between market partners and other organizations (e.g. banks, administration) and with social networks. The ERP IV system (see Table 3) is extended in relation to ERP III by solutions in the field of using artificial intelligence (cognitive programs), machine learning, predictive analytics, Internet of Things (IoT), Big Data, Industry 4.0 and fog computing. As a result, the ERP IV system will supervise intelligent networks that will connect machines, systems, products, processes, customers and suppliers. Thanks to this, it will be possible to further deepen automation, continuously optimize products and processes, collect and process huge amounts of data in real time, operate machines and devices, as well as quickly adapt to changes in the market situation. The assumption for ERP IV systems is also supporting design and production with three-dimensional printing. The ERP IV system, automatically implementing many processes, eliminates delays in making managerial decisions and may lead to increased competitiveness – as a result, it can meet the requirements of the Real Time Enterprise concept.

According to A. Bytniewski and others, the ERP IV system should consist of the following elements (A. Bytniewski et al., 2018):

- corporate portal – an IT platform integrating data from the company and its environment in order to offer users personalized and convenient access to data through a uniform interface,
- distributed mobile solutions – tools designed especially for mobile devices (mainly smartphones) that enable users to remotely operate the system using wireless technologies,

- applications integrated with the internal IT system supporting online stores, exchanges, auctions, which, acting as part of corporate portals, will ensure proper communication with cooperators,
- software that implements communication with cooperators based on solutions available under EDI, supporting the adopted standards (e.g. EDICACT, XML, CXML).

Feature	ERP	ERP II	ERP III	ERP IV
Role	company optimization	company optimization, participation in an extended supply chain, e-commerce	company optimization, participation in an extended supply chain, e-commerce	As in ERP III, plus automatic generation and execution of decisions, especially at the operational and tactical level
Domain	production and distribution	all industries and market segments	all industries and market segments, organization of the environment	all industries and market segments, organization of the environment
Computerized areas	production, sales and distribution, finance	connecting industries / branches, specific industrial and / or service processes	all activities of the company in combination with a diverse environment	all spheres of the company's operation in connection with a diverse environment (e.g. banks, insurance companies, offices)
Processes	internal, hidden	internal and external that are integrated with one another	internal and external that are integrated with one another, reengineering of business processes realization	As in ERP III, plus possibility of remote management of business processes
Architecture	closed, non-networked, monolithic	open, web-based, component	based on various networks (wired and wireless internet)	As in ERP III, plus self-adjusting, modifying its own behavior in response to changes in the operating environment
Data	internally generated and used	made available internally and externally at wired internet locations	shared internally and externally in real time anywhere	shared anywhere and can also be transformed into knowledge
Information technologies used	local computer networks	internet network (wired network dominates)	wired and wireless internet using mobile devices	As in ERP III, plus fog computing, IoT
Technologies in software	internal databases, data warehouses	internal databases, with the external source, data warehouses	artificial intelligence, big data, in-memory processing	artificial intelligence, big data, in-memory processing, big management
Mode of operation	in an own center	in an own center	in an own center and transformed in the cloud	in an own center; however, cloud and fog computing is dominant

Tab. 3. Differences between successive generations of ERP systems. Source: Bytniewski (2018).

The above solutions will facilitate the dynamic collection, processing and analysis of data and information from both the company and its environment and their transformation into knowledge and effective decisions of company managers. New possibilities of communication and cooperation of the company with suppliers, customers and other organizations, integrated with ERP systems will support the digital transformation of enterprises.

In conclusion, it should be emphasized that ERP systems are currently undergoing huge changes, mainly as a result of technological and business changes. Regardless of the proposals contained in subsequent generations of ERP systems, according to the author, the most important directions for the development of ERP systems include:

- Verticalization of ERP systems – development of ERP systems dedicated to the needs of enterprises from specific industries and the progressive specialization of suppliers offering industry-specific ERP systems. In ERP systems for given industries, functions are created and developed to support the implementation of industry-specific and key business processes. Suppliers of the offered ERP systems also create specialized add-ons that allow the system to be better adapted to the needs of enterprises from various industries.
- Cloud ERP – the growing importance of cloud computing in the provision and use of ERP systems. The main factors behind the migration of ERP systems to the cloud are flexibility, availability, lower costs of implementation, maintenance and development of IT infrastructure, shorter implementation time, lower risk, standardization of processes and increased security of resources. Cloud ERP systems will, in the long run, ensure better cooperation with existing local IT systems and increase integration with other systems and databases available in the computing cloud (e.g. cooperator systems, portals and websites, social media, public organization systems, open public data, etc.). Cloud ERP systems will improve their intuitive operation and ergonomics of users' work, as well as increase the possibility of adjusting them to the needs of the company and its employees.
- Mobility – widespread use of mobile tools in the field of remote access to ERP systems. Mobile devices in which the displayed data is adjusted to the screen size provide online access to data stored in ERP systems and the ability to perform work. Mobility for managers provides access to data describing the state of the company, allows you to make inquiries, make decisions, approve transactions, thus making it easier to manage the company regardless of location. Mobility in ERP systems will improve the efficiency of work of many departments of the company and ensure faster response to market changes.
- Internal and external integration of ERP systems – ERP systems will develop the areas supported so far and cover more and more spheres of business activity and unite the functions of other IT systems and

solutions (e.g. WMS, OHS, MES, KMS, CAD/CAM, BI, TMS, GIS). The ability of ERP systems to collect and process data from internal and external sources will also increase. Ultimately, ERP systems will become the main platform for cooperation, communication and data exchange between company employees and business partners, devices (e.g. sensors) and machines (e.g. autonomous forklifts, automatic storage racks, etc.) and other IT systems (e.g. e-business). The integration will cover the company's supply chains (including e-commerce), ensuring not only real-time access to business partners' data, but also dynamic modeling of supply chains and optimization of product flows depending on the needs of customers. There will be a bigger expansion of the existing functionalities and new functions and solutions will appear in ERP systems (e.g. flexible and agile tools in the area of FMS production – Flexible Manufacturing Systems, Wise Manufacturing, Agile Manufacturing). ERP systems will increasingly support the existing and constantly evolving business processes as well as new business processes (e.g. Intelligent Asset Management, Predictive Maintenance). There will also be an increasing integration of ERP systems with Big Data solutions that analyze millions of data from various sources (e.g. from social networks) and are able to capture trends or build, e.g., customer behavior patterns.

- Automation in ERP systems – in ERP systems, the saturation with Artificial Intelligence solutions and Machine Learning algorithms will increase, resulting in process automation, increased productivity, improved relationships with customers and suppliers, and improved data processing and analysis (e.g. optimization of production scheduling, analysis of user behavior that leads to interface personalization and proposing further actions, intelligent reporting enabling multidimensional data analysis, three-dimensional visualizations, comparing and drawing valuable conclusions in terms of improving tasks or processes, as well as proposing and recommending possible actions and generating notifications in the event of exceeding the limit values, intelligent assistants advising users on the next actions, the possibility of voice input of commands). The implementation of RPA Robotic Process Automation solutions (special algorithms that automate tedious and repetitive user activities in the field of data processing) or self-driving can independently enter and analyze various types of data (e.g. automatic loading of documents into the ERP system, the possibility of automatic ERP system configuration). In ERP systems, the Internet of Things (IoT) solutions will be applied more extensively, thanks to which an increasing number of sensors will be able to download, process and send important data and make automatic and independent decisions in various areas of enterprise activity (e.g. production, logistics). By expanding intelligent networks that connect processes, machines, sensors, products and various IT systems,

ERP systems will gain the ability to predict or detect threats, present possible scenarios to solve problems and even automatically eliminate their negative effects. Artificial Intelligence and automation of data processing in ERP systems will also support enterprises in acquiring new customers (analysis and generating promotion proposals), as well as new employees and suppliers (analysis of internal data and internet resources and creating recommendations). Automation and consolidation of processes will facilitate the control of a selected area of the company's activity (e.g. planning, monitoring and coordination of the production process, work of production staff, machines and the quantity and quality of available resources), it will also allow for automatic preparation of reports and then their transfer (e.g. to board members or public organizations). ERP systems will also acquire the ability to self-adapt to the dynamically changing needs of the company and its employees, it will also be possible to increase the availability of ERP systems by automatically repairing their own defects (self-healing), which can be done without the interference of technical support employees; however, the systems will automatically inform appropriate services about the detection of errors or damages and actions taken. ERP systems, having the ability to collect and process data from various sources, will acquire the ability to self-learn and create knowledge, which in turn will define and determine the „intelligence” of enterprises, enabling them to better understand the market, respond quickly, adjust business processes and optimize the use of available resources.

- Multimedia ERP systems – ERP systems will be created that will enable users to give commands by voice, give commands with gestures, operate the system in 3D and on multiple monitors. Multimedia ERP systems will increase the automation of processes and operations and by facilitating faster access to the necessary data, information or knowledge, they will optimize decision-making processes.
- Process ERP systems – the creation of ERP systems with built-in and integrated tools for modeling business processes (e.g. BPMN notation) and facilitating quick mapping of generated processes in ERP systems, which facilitates process optimization, business flexibility and faster response to market changes.
- Minimizing the implementation time of ERP systems – in recent years, there has been a significant reduction in the implementation time of ERP systems, also for medium and large enterprises. In the coming years, this trend will be maintained by suppliers providing improved tools and methodologies to facilitate the ERP system implementation process (e.g. preconfigured systems for typical and repeatable processes). A radical approach to the implementation of ERP systems (LIAD model – Live in a Day) will also be developed, minimizing the implementation of the ERP system up to 24 hours (without taking into account training

- and modifications), dedicated mainly to small enterprises and startups that do not have complicated business processes.
- Increased popularity of Open Source ERP systems – in the next few years, ERP systems offered as Open Source will have a greater market share. The popularity of this type of solutions will be influenced by the pressure to reduce IT costs, the growing number of entities implementing such systems, the dynamic development of social networks supported by users of Open Source ERP systems and the emergence of opportunities to co-finance the development of such systems as well as implementation works and support for enterprises.

5. Conclusion

The complexity, unpredictability and dynamics of the contemporary business environment, as well as striving to automate business processes and improve internal and external flows of information resources, determine the use of various IT solutions in enterprises. One of particularly important IT tools influencing the improvement of management processes and improvement of the company's results are integrated ERP-class IT systems. This class of IT systems has the ability to support and integrate almost all areas of the company's activity and to significantly support the management of various management levels in reporting, monitoring and analyzing business processes.

ERP systems, since their inception until now, have undergone a significant evolution mainly due to the growing needs of customers and dynamic technological progress. The digital transformation of many enterprises requires the use of an ERP system that will enable the optimization of internal and external processes carried out together with business partners. The current generation of management information systems, discussed in the literature, is referred to as ERP IV. Regardless of the proposed generations of ERP systems with different possibilities, the analysis of the ERP market enables the presentation of proposals for possible development directions for this class of systems. The following directions of development of ERP systems have been distinguished: verticalization, Cloud ERP, mobility, internal and external integration, automation of ERP systems, growing popularity of Process ERP and Open Source ERP systems. The directions outlined by the author, on the one hand, constitute a voice in the discussion on further perspectives for the development of ERP systems, on the other hand – they may constitute a premise for companies that analyze and choose a new system of this class to support their activities in the digital economy.

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Book review: Marian Gorynia, *Przedsiębiorstwo w biznesie międzynarodowym. Aspekty ekonomiczne, finansowe i menedżerskie*

***[Enterprise in International Business. Economic, Financial
and Managerial Aspects], PWN, Warsaw 2021***

Introduction

The reviewed book is 503 pages long and consists of an introduction, seven parts, a bibliography and an index. The first part addresses the enterprise as a subject of knowledge in international business. The second one presents the context of foreign expansion of enterprises. The third section is an overview of theories (models) pertaining to foreign expansion of enterprises. The fourth and fifth parts contain considerations on the strategy of their foreign expansion. The sixth one discusses the methods of selecting an entry into foreign markets. The last part covers normative and prospective issues of foreign expansion of enterprises. The structure of the reviewed publication is logical and synthetically presented in the introduction (*see Figure 1, page 19*).

The author defines four basic goals of the publication (*see page 13*): (1) to identify the reasons and contextual conditions leading enterprises to start operating in foreign markets; (2) to describe and critically assess the theories (models) of foreign expansion of enterprises; (3) to review the forms of enterprises' entry into foreign markets and to determine their strengths and weaknesses; (4) to characterize the tool and methodological set used to make decisions related to foreign expansion of enterprises.

Distinguishing Features of the Book

The following distinguishing features of the reviewed publication can be identified.

First, the book assumes the enterprise as the basic unit of analyses and deliberations. It complements, develops and updates previous publications in the field of international business (i.e. Fonfara, 2009; Fonfara et al., 2000; Glinka & Jelonek, 2010; Gołębiowski, 1994; Gorynia, 2007; Jarosiński, 2013; Koźmiński, 1999; Obłój & Wąsowska, 2014; Rozkwitalska, 2007; Rymarczyk, 2004; Rymarczyk 2012; Stepień, 2019; Wach, 2012; Wiktor, 2017; Witek-Hajduk, 2010; Witek-Hajduk, 2019; Zorska, 2007). Its author undertook the difficult task of describing the behavior of enterprises in internationalization processes in the context of numerous, often contradictory, theories (models) of international trade, foreign direct investment, international enterprise and enterprise internationalization (*see Part III*). The theoretical models

are supplemented with more practical considerations on the strategy of foreign expansion of enterprises (*see Parts IV, V and VI*).

Second, the determinants of how enterprises function in foreign markets are discussed, taking into account both a higher level (globalization processes, industry structure) and a lower level (components of the organizational structure and employees). This approach created a unique opportunity to indicate that the behavior of enterprises in internationalization processes is the result of many external and internal variables.

Third, a distinguishing feature of the reviewed book is its interdisciplinary nature. In the introduction, the author states that the dominant research perspective is economic science (*see page 15*) but many reflections rest upon the achievements of such scientific disciplines as: management science, finance, socio-economic geography, spatial management and other disciplines in the field of social sciences.

Fourth, an essential feature of the publication is the combination of the characteristics of a classic monograph and of a textbook. This may be exemplified by the discussion of theories (models) and strategies of foreign expansion of enterprises. This is done in a logical manner with great care for the definition and classification order. On the other hand, arguable problems are signaled and open-ended questions are posed. The author also makes numerous references to the research foundation by presenting the results of his own research and that of other Polish and foreign scholars.

Fifth, the multiplicity of research approaches is taken into account. The dominant research approach is descriptive – that is, a description of the enterprise's behavior in the processes of activity internationalization, including specific temporal and spatial factors (*see Parts III, IV and V*). The reviewed book also contains considerations related to the normative approach, i.e. recommendations for managers and politicians in the case of their managerial and political decisions (*see Part VI and Chapter 37 in Part VII*), and the prognostic approach, namely a search of an answer to the question of how the external environment of the enterprise will change and how these changes will affect the behavior of enterprises in foreign expansion (*see Chapters 38 and 39 in Part VII*). The author's deliberations concerning the normative and prognostic approaches which refer directly to Polish enterprises are particularly compelling.

Sixth, the reviewed publication is addressed to many groups of readers. The following can be distinguished (*see page 22*): (1) academics dealing with international business issues; (2) students of: economics, finance, management, international relations, socio-economic geography; (3) doctoral students of doctoral schools in the following disciplines: economics and finance, management and quality sciences, socio-economic geography and spatial management, and political and administration sciences; (4) managers of enterprises operating in foreign markets; (5) managers of enterprises planning foreign expansion; (6) decision-makers in the field of economic policy. Each group of readers will find interesting considerations and analyses by the author of the book.

Seventh, the decision-making aspects in the internationalization of enterprises' operations are highlighted. The author presents, in an orderly and comprehensive manner, key decisions connected with foreign expansion of enterprises: (1) whether to undertake foreign expansion – the dilemma between internationalization and diversification of activities (*see Chapter 10*); (2) when to start operating in foreign markets – the dilemma between sequential and parallel entries (*see pages 203–206*);

(3) what forms of entering foreign markets to choose – the dilemma of selecting the form of entry (export, non-capital cooperation, capital cooperation and foreign direct investment – *see Part V*); (4) what resources should be involved in the internationalization process – the dilemma of whether the chosen form of entering foreign markets is profitable (*see Annex 1 and Part VI*).

Eighth, the reviewed book also includes considerations on the functioning of enterprises in foreign markets. Four dimensions were used for this description: standardization, integration, configuration and coordination. Such an approach enables a multifaceted analysis of the enterprise's operations in a global dimension (*see Chapter 18*).

Ninth, many issues discussed in the reviewed publication are highly topical. Particularly noteworthy are the considerations concerning the impact of the COVID-19 pandemic on globalization processes, economic policy and the functioning of enterprises in foreign markets (*see Chapter 39*). The author poses a number of vital questions: (1) will the pandemic stop globalization processes?; (2) will the pandemic affect the economic competition between the US and China?; (3) will the pandemic change the development and investment priorities of governments and enterprises?; (4) will the pandemic cause a shift from the market economy principles towards a greater role of the state in the economy?; (5) how will the pandemic affect international cooperation between states and enterprises?; (6) will the pandemic contribute to changes in the functioning of transnational corporations – e.g. changes in the configuration of the value chain?

Tenth, further research directions are identified (*see Chapter 40*). The author focuses on further research directions in the methodological dimension (*see page 461*): (1) seeking a balance between empirical and theoretical research; (2) research relating to the short and long term; (3) taking into account different levels: macro, meso (industry), micro (enterprise) and individual (owners, managers and employees); (4) enhancing the role of qualitative research, including case studies; (5) considering various approaches, i.e. descriptive, normative and prognostic; (6) making the conducted research more interdisciplinary.

Eleventh, the used literature pertaining to the subject in question is abundant. The list of references spans 34 pages. This proves not only the author's erudition but also his vast knowledge of the research area.

Comments – Arguable Issues

Several critical comments can be made on the book under review.

First and foremost, the theories presented therein relate primarily to highly economically developed countries (i.e. the United States, Western European countries). A significant supplement would be a description of behaviors in the internationalization of enterprises from emerging countries. Four theories can be used for such a description (Luo & Tung, 2018): springboard perspective; linkage-leverage-learning framework; ownership (but unique) advantage logic; and institutional arbitrage logic. The **springboard perspective** focuses on the assumption that emerging-market enterprises internationalize their operations to gain strategic assets, cope with domestic institutions and compensate for a lag in economic development processes. Internationalization is treated as a springboard for attaining strategic

goals and building competitive advantages. Active operations in foreign markets, through the establishment of joint ventures, mergers and acquisitions of foreign entities from highly economically developed countries, enable the acceleration of internationalization and the building of assets such as: access to advanced technology, managerial competences and skills and a recognizable brand (Luo & Tung, 2007; Kumar et al., 2020; Luo & Tung 2018; Wąsowska, 2014). The **linkage-leverage-learning framework** presents a way of building competitive advantages by enterprises from emerging countries through establishing relationships with foreign entities in order to acquire assets that are not available in the home market (technological, marketing and human assets). Subsequently, such assets are leveraged, which means that they are used to improve the enterprise's own business with a relatively low level of financial commitment. Finally, as a result of the learning process, the acquired assets are modified, improved and refined, thereby creating competitive advantages of enterprises (Mathews, 2002, 2006; Wąsowska, 2014). The **ownership (but unique) advantage logic** is based on the assumption that enterprises from emerging countries have – in relation to entities from highly economically developed countries – unique ownership advantages as they better understand the needs of buyers (mainly from market segments with high price sensitivity), search for an adequate relation between the price and quality of the offered product, apply solutions that lead to lower operating costs and enable operations in a difficult and unstable environment. These advantages are contextual and ensue from the country of origin of the enterprise and industry specificity (Ramamurti, 2009; Rugman, 2009; Narula, 2012; Ramamurti, 2012). The **institutional arbitrage logic** describes two ways in which entities from emerging countries build their position in foreign markets. First, they reduce the operational risk by entering foreign markets that are characterized by greater legal and political stability than in the home country. Secondly, compared to enterprises from highly developed countries, they are used to operating in other emerging countries with weak institutions. They will adapt more easily and have a better chance of surviving in such conditions (Boisot & Meyer, 2008; Cuervo-Cazurra & Genc, 2008; Witt & Lewin, 2007; Yamakawa, Peng, & Deeds, 2008).

Second, the dilemma of assessing the attractiveness of the foreign market has not been described in the reviewed publication, hence a failure to answer the question of which country (countries) should be chosen for foreign expansion. In the literature, many attempts to formalize the process of assessing the attractiveness of foreign markets can be identified (Górecka & Szałucka, 2013; Papadopoulos, Chen, & Thomas, 2002; Cavusgil, Kiyak, & Yenyurt, 2004; Mullen & Sheng, 2006; He et al., 2016; Vanegas-López et al., 2021). These processes can be structured under four basic models: conceptual, clustering, country ranking and naïve. The **conceptual model** consists of three phases: screening, identification and selection (Cavusgil, 1985; Koch, 2001; Kumar, 1994; Root, 1994). Screening involves the assessment of the macro environment to eliminate states (markets) that are not attractive enough for the internationalization of an enterprise's activities. In the second phase – identification – analyses are focused on assessing the attractiveness of the economic sector (industry) in the countries selected in the first phase of assessment. In the selection phase, the ability of the entity internationalizing its operations to achieve a competitive advantage in a new geographic market in a given sector is assessed. The **clustering model** consists in assessing the attractiveness of foreign markets based on the procedure of clustering countries according to their similarity from

the point of view of a specific set of criteria. The key analytical technique in this procedure is cluster analysis (Cavusgil, 1997; Cavusgil, Kiyak, & Yeniurt, 2004; Liander, Terpstra, Yoshino, & Sherbini, 1967; Sethi, 1971; Mullen & Sheng, 2006). The **country-ranking model** leads to a country ranking based on a multi-criteria assessment of the market potential of the countries under assessment. This procedure employs analytical techniques such as regression analysis or multivariate analysis (Papadopoulos & Denis, 1988; Ozturk, Joiner, & Cavusgil, 2015; Cavusgil, Kiyak, & Yeniurt, 2004). The **naïve model** is a simple decision-making process based on the search for countries with a high degree of similarity and easily accessible information, enabling the selection of the “most” attractive foreign market. The key criteria for selecting a foreign market are: geographic proximity, knowledge of the language, cultural similarity, colonial heritage, large emigration from the home country, ethnic origin of the investor, etc. (Siegel, Licht, & Schwartz, 2013; Cavusgil & Godiwalla, 1982; Kobrin, Basek, Blank, & Palombar, 1980; Kogut & Singh, 1988).

Third, de-internationalization processes are only briefly presented in the reviewed publication (page 229). A broader discussion of this issue could draw on the legitimacy theory (Turner, 2011; Zhang et al., 2018), which not only explains enterprises' decisions to exit or reduce the involvement in a given foreign market but also provides a perspective for analyzing the behavior of entities in foreign markets. A useful analytical tool is the legitimacy matrix proposed by Turner (2011, see Figure 1). The matrix is built on two dimensions: strategic and institutional (Turner, 2011). The strategic dimension encompasses elements from the external and internal environment. In the external environment, it is possible to distinguish commercial adjustment (to the principles and conditions of running business), relational adjustment (acceptance by stakeholders), social adjustment (compliance with cultural norms and values in a given society) and investment adjustment (compliance with the expected rate of return on financial outlays incurred by financial institutions). The internal environment determines the acceptance of decisions and actions of an organization unit by its headquarters and other units and the adaptation of common policies, procedures and practices. The institutional dimension involves the adjustment of an organization to the political and legal environment in a specific country. In the individual fields of the matrix, strategic options can be distinguished such as of developmental, stabilization, restructuring (operational, organizational and strategic) and de-internationalization nature (Turner, 2011; Karasiewicz, 2018).

		Institutional legitimacy	
		Low	High
Strategic legitimacy	High	Field A Operational restructuring Organizational restructuring	Field C Development option Stabilization option
	Low	Field B De-internationalization	Field D Development option Strategic restructuring De-internationalization

Fig. 1. Legitimacy matrix. Source: As developed by the author based on Turner (2011).

Fourth, this book would be significantly supplemented by striving to answer the question of how digital transformation affects the processes of internationalization of enterprises' activities. This issue can be approached in a narrow and broad way. A narrow approach would apply to the use of the internet in the internationalization of enterprises' operations. The analysis is then focused primarily on the use of electronic channels in the sale of products in foreign markets, management of the international (global) supply chain in the internet environment, global marketing communication based on the internet and social media, and the use of the internet to obtain knowledge about foreign markets, thus reducing the geographic distance (Witek, 2019; Sinkovics, Sinkovics, & Jean, 2013). A broader perspective involves the presentation of the role of digital transformation in the configuration of enterprises' business models, taking into account internationalization processes, thereby including born globals in the development of the concept (Abrahamsson, Boter, & Vanyushyn, 2019).

Fifth, it would be worth considering the preparation of a new book with extensively presented examples of processes of internationalization of Polish enterprises (longitudinal case studies). Such a publication could be structured as follows (Obłój, 2020, pp. 124–128): (1) enterprises that started internationalization before 1990, (2) entities that entered foreign markets in the 1990s, and (3) enterprises that started activity in foreign markets after Poland had joined the European Union.

I realize that were my comments in items 1-4 taken into account, this would increase the length of the book under review, which is anyway extensive, with approximately 500 pages. This would force the author to cut short, in the next edition, many important and interesting considerations discussed in the current publication.

Conclusion

The book by Professor Marian Gorynia, Ph.D., is a unique, comprehensive and up-to-date publication in the field of international business. While drafting its next edition, the author should focus more on the micro perspective (i.e. an enterprise planning to enter and operating in foreign markets), a broader inclusion of technologies related to digital transformation in business activities and the specificity of emerging countries. This would allow greater and more unique logic of the deliberations not only in the Polish but also international publishing market.

The reviewed book provides evidence that Professor Marian Gorynia belongs to a group of outstanding scholars in Poland – in the research field of international business. With full conviction, this publication can be recommended not only to men of science but also to business practitioners, doctoral and other students. It is a compendium of knowledge about the behavior of enterprises in the processes of internationalization of their operations.

Warsaw, 28 September 2021

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